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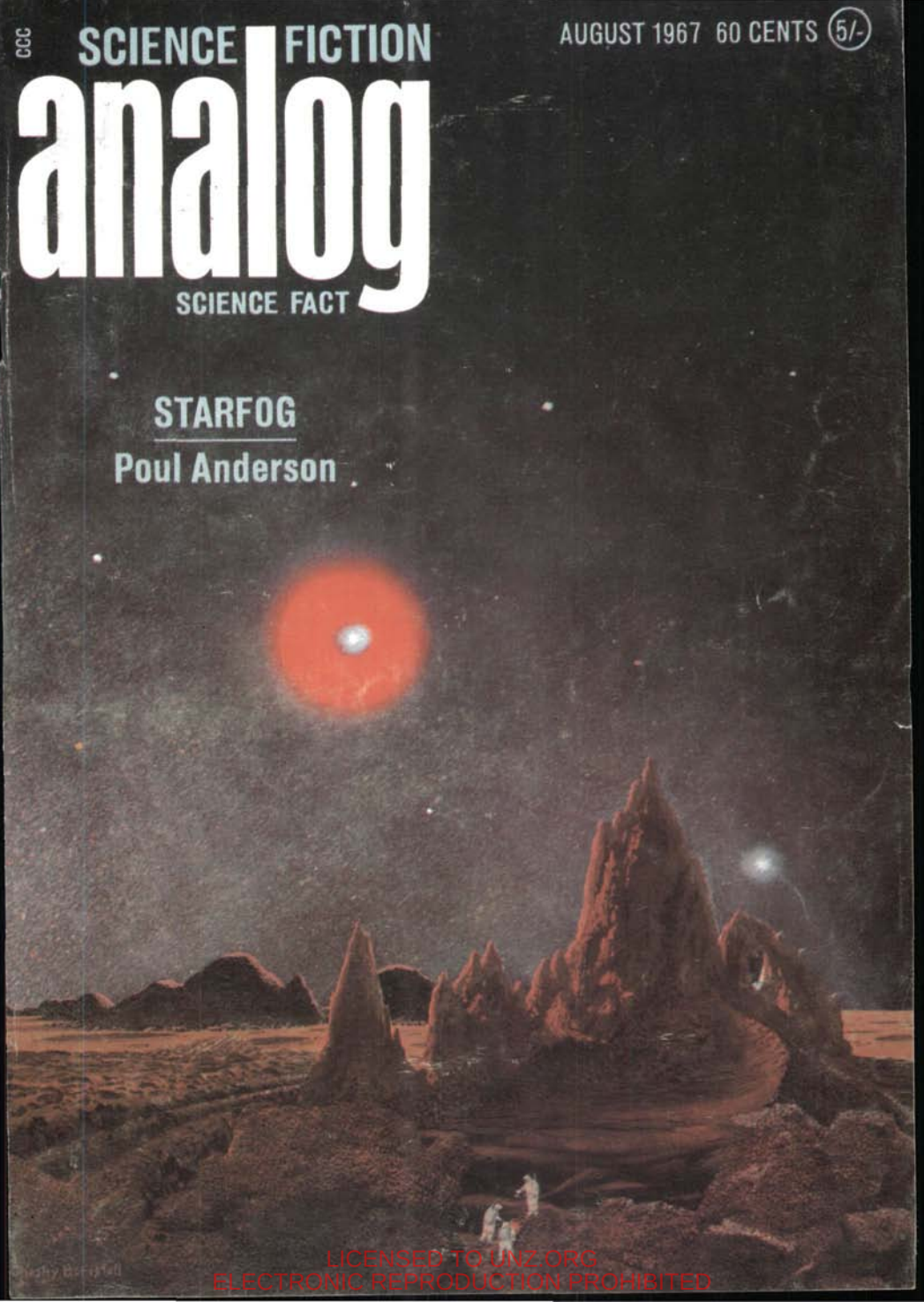
Poul Anderson



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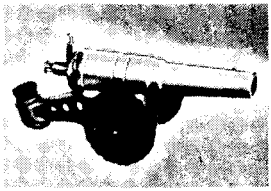

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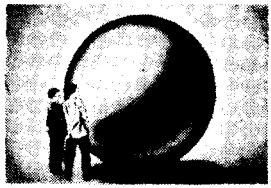

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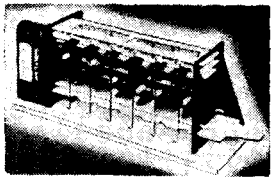

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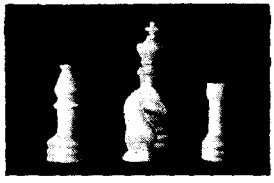

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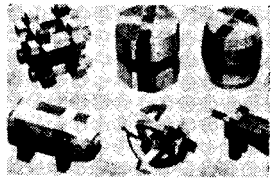

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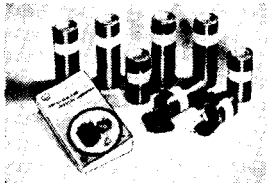

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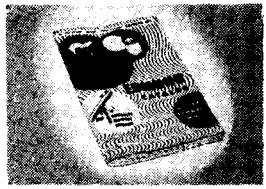

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The Red and Blue Giant

John W. Campbell

An editorial

Chesley Bonestell's cover this month illustrates Poul Anderson's yarn, "Starfog." It also represents a lot of hard work and thinking and trying out of ideas developed by Anderson and Bonestell in collaboration —and I added one little item of my own. Primarily, however, author and artist, who live reasonably near each other, worked out the problems.

First, it was determined by trial, that nothing we can publish will give the effect we really wanted—what the night sky of a terrestroid planet in the middle of a globular cluster would look like. The viewpoint of the cover is from a planet on the outer, thin fringes of the Starfog Cluster, where the real cluster is visible only as a haze of fire in the distance.

In the center of a globular cluster, stars are packed at half light-year distances; in any direction you looked, the close packed stars would be so thickly sown that you'd see tens of thousands. The night sky would be a glowing mass of stars, ranging in magnitude from things so bright and close as to outshine anything in our night-sky but the Moon—Venus or Jupiter would be weak and dim by comparison, while Sirus, our brightest star, wouldn't be distinguishable from the multi-thousand-stars-mass.

The effect can not be achieved with pigment-on-white-paper. It could only be possible with a trans-luminated transparency, because the range of light-intensities required isn't possible with reflection presentation.

Unfortunately, at no time in the foreseeable future will it be economically possible to have a cover produced by direct photography on a transparent plastic material on any magazine. The darned things would cost about ten dollars apiece, even in 100,000-copy lots—and I

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don't expect any megabuck issues of Analog soon.

So we had to settle for this outside-looking-in view. You'll have to contribute the rest of the indescribable glory of a globular cluster from imagination—at which most science-fictioneers are reasonably competent!

Our red-white-and-blue giant sun in the foreground of the star field, however, is "my own invention," with which we can have some fun.

Now the astrophysicists, when they refer to red, yellow, white, blue, and violet stars, are somewhat exaggerating the case. Take a look through a modest telescope—say a six-inch reflector, a size quite common on front lawns and handy hills these days—at one of the red giant stars, Betelgeuse for instance. If you expect to see something like a traffic stoplight—sorry, you won't. Or Rigel or Deneb, listed as blue-white super-giants; they aren't the color of a clear summer sky. The "yellow" stars don't look like amber caution lights, either. They're red-*white,* and yellow-*white* and blue-*white,* but the emphasis is on the white. In one case, the photographs taken through filters show a marked relative excess of red; in the other extreme, a marked excess in the blue region of the spectrum.

Our Sun, as it sinks toward the horizon, changes from the familiar brilliant white—though it's a yellow star to the astrophysicist—toward the red, the color deepening more and more until, at sunset on some evenings, it does show a real traffic-light red disk. Not because the Sun's changed characteristics of course, but because of the filtering effect of a long, dusty path of atmosphere. The longer wavelengths of light are getting through, while the shorter ones are being scattered and/or absorbed by dust, water vapor, and "statistical molecular conglomerates" in the atmosphere.

That latter classification refers to the phenomenon that any statistical process has statistical runs. In tossing coins you do *not* get heads, tails, heads, tails, heads, tails, heads, tails . . . in neat, one-for-one alternation. The statistical trend approaches a .5 probability for each—but not on a one-for-one succession. Rather, you'll get heads, tails, tails, tails, heads, tails, heads, heads, tails, heads, heads, tails . . . et cetera.

The molecules of the air move statistically at random; over large areas, the distribution of molecules is even—but inevitably, at any given instant, there will be statistical runs over small volumes. A concentration at one point well above "normal atmospheric pressure" by sheer chance, a partial vacuum in another volume. These are, of course, on a very small scale—about the wavelength of blue light.

And that, children, is why the sky is blue. If the atmospheric pressure were much lower, the statistical run pockets would reach the size of red-light wavelengths—only then we

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couldn't see the effect, because their density would be so low as to be pretty ineffective.

Now let us consider a "red giant sun." Current astrophysical theory holds that the red giant stage comes to a main-sequence star when its original supply of hydrogen for thermonuclear fusion is beginning to run out. Down at the core of the normal main-sequence star the temperature and pressure are determined by the equilibrium between the rate of energy released (which produces radiation which forces its way out through the vast surrounding mass of the star, and thus presses that mass outward) vs. the immense force of the star's own gravity.

The more massive a star is, the greater the internal gravity-pressure which has to be balanced; this requires a faster rate of thermonuclear reaction, a more rapid consumption of hydrogen fusing to produce helium. A star thirty times as massive as the Sun has to produce tens of thousands of times as much radiation to press against the inpressing gravitational force. This higher rate of reaction takes only a moderate increase in core temperature, because the hydrogen fusion reaction is very temperature sensitive—a small change in temperature, just a few percent—makes the difference between no thermonuclear fusion in a billion years, and a twenty percent fusion in twenty nanoseconds, as in an H-bomb.

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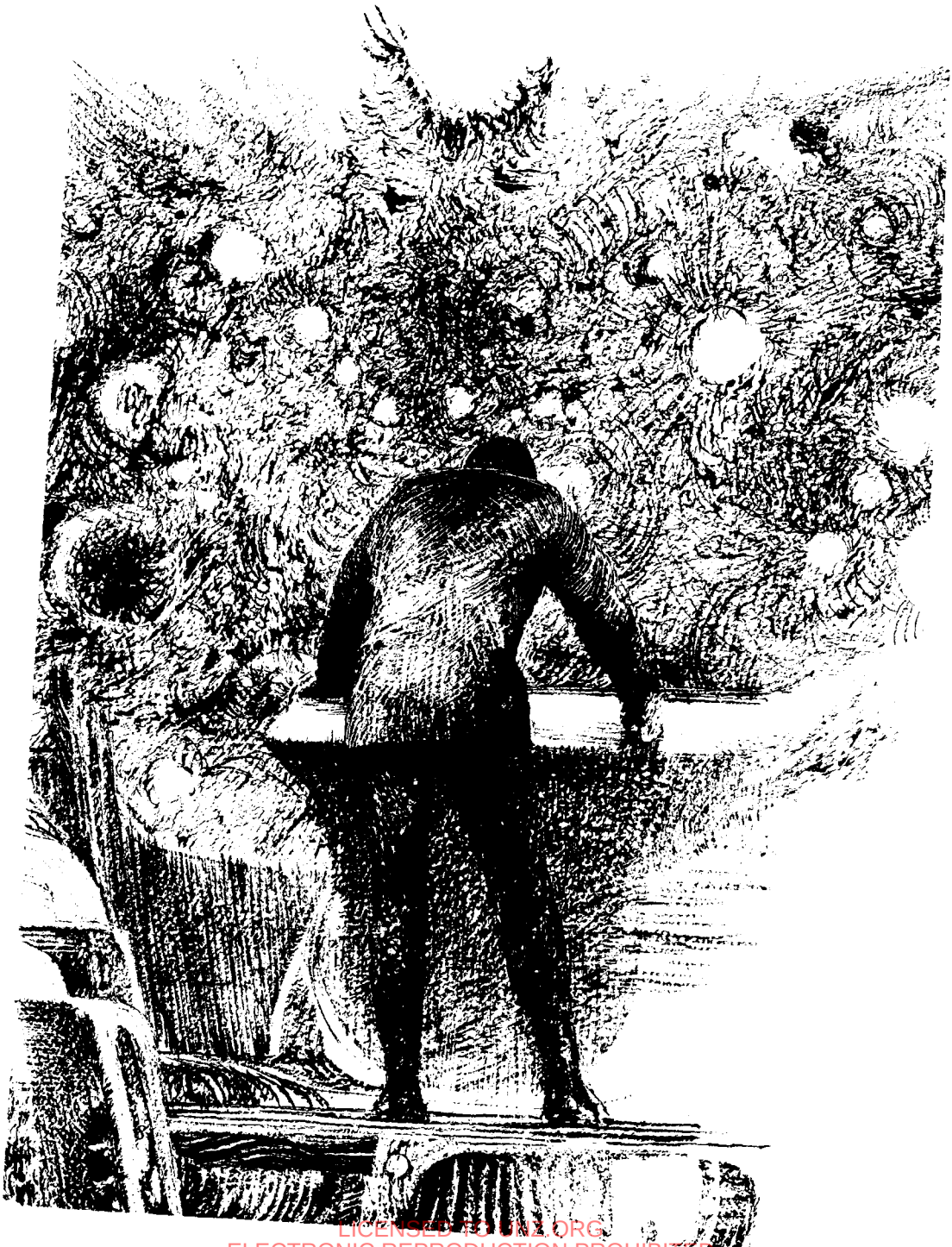

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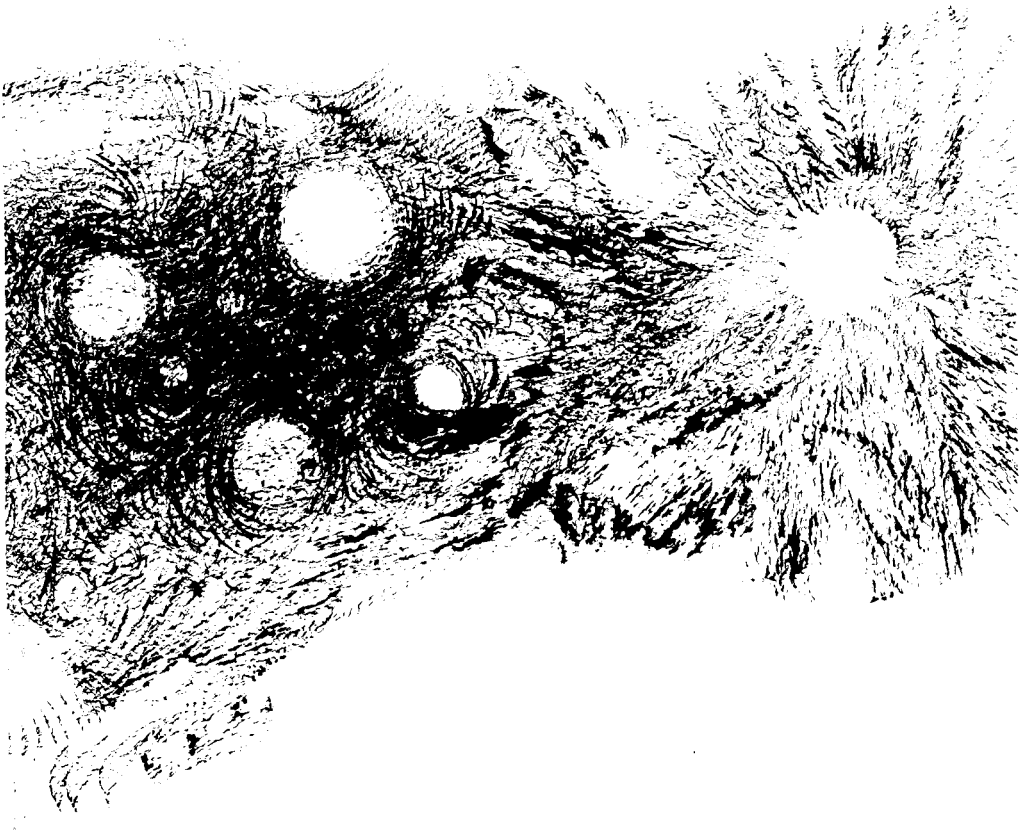

Starfog

They were obviously not only humanoid but human—yet they were lost from some place so weird it must be in another Universe. A place where stars crowded within half a light-year—and all space was filled with a glowing fog so dense that ships lost all hope of finding their home-world again!

POUL ANDERSON

Illustrated by John Schoenherr

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"From another universe. Where space is a shining cloud, two hundred light-years across, roiled by the red stars, that number in the many thousands, and where the brighter suns are troubled and cast forth great flames. Your spaces are dark and lonely."

Daven Laure stopped the recording and asked for an official translation. A part of *Jaccavrie*'s computer scanned the molecules of a plugged-in memory cylinder, identified the passage, and flashed the Serievan text onto a reader screen. Another part continued the multitudinous tasks of planetary approach. Still other parts waited for the man's bidding, whatever he might want next. A Ranger of the Commonalty traveled in a very special ship.

And even so, every year, a certain number did not come home from their missions.

Laure nodded to himself. Yes, he'd understood the woman's voice correctly. Or, at least, he interpreted her sentences approximately the same way as did the semanticist who had interviewed her and her fellows. And this particular statement was as difficult, as ambiguous as any which they had made. Therefore: (a) Probably the linguistic computer on Serieve had done a good job of unraveling their basic language. (b) It had accurately encoded its findings—vocabulary, grammar, tentative reconstruction of the underlying world-view—in the cylinders which a courier had brought to Sector HQ. (c) The reencoding, into his own neurones, which Laure underwent on his way here, had taken well. He had a working knowledge of the tongue which —among how many others?—was spoken on Kirkasant.

"Wherever that may be," he muttered.

The ship weighed his words for a nanosecond or two, decided no answer was called for, and made none.

Restless, Laure got to his feet and prowled from the study cabin, down a corridor to the bridge. It was so called largely by courtesy. *Jaccavrie* navigated, piloted, landed, lifted, maintained, and, if need be, repaired and fought herself. But the projectors here offered a full outside view. At the moment, the bulkheads seemed cramped and barren. Laure ordered the simulacrum activated.

The bridge vanished from his eyes. Had it not been for the G-field underfoot, he might have imagined himself floating in space. A crystal night enclosed him, unwinking stars scattered like jewels the frosty glitter of the Milky Way. Large and near, its radiance stopped down to preserve his retinas, burned the yellow sun of Serieve. The planet itself was a growing crescent, blue banded with white, rimmed by a violet sky. A moon stood opposite, worn golden coin.

But Laure's gaze strayed beyond, toward the deeps and then, as if in search of comfort, the other way,

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toward Old Earth. There was no comfort, though. They still named her Home, but she lay in the spiral arm behind this one, and Laure had never seen her. He had never met anyone who had. None of his ancestors had, for longer than their family chronicles ran. Home was a half-remembered myth; reality was here, these stars on the fringes of this civilization.

Serieve lay near the edge of the known. Kirkasant lay somewhere beyond.

"Surely not outside of space-time," Laure said.

"If you've begun thinking aloud, you'd like to discuss it," *Jaccavrie* said.

He had followed custom in telling the ship to use a female voice and, when practical, idiomatic language. The computer had soon learned precisely what pattern suited him best. That was not identical with what he liked best; such could have got disturbing on a long cruise. He found himself more engaged, inwardly, with the husky contralto that had spoken in strong rhythms out of the recorder, than he was with the mezzo-soprano that now reached his ears.

"Well . . . maybe so," he said. "But you already know everything in the material we have aboard."

"You need to set your thoughts in order. You've spent most of our transit time acquiring the language."

"All right, then, let's run barefoot through the obvious." Laure paced a turn around the invisible deck. He felt its hardness, the vibration back through his sandals, he sensed the almost subliminal beat of driving energies, he caught a piney whiff of air as the ventilators shifted to another part of their odor-temperature-ionization cycle; but still the stars blazed about him, and their silence seemed to enter his bones. Abruptly, harshly, he said: "Turn that show off."

The ship obeyed. "Would you like a planetary scene?" she asked. "You haven't yet looked at those tapes from the elf castles on Jair that you bought—"

"Not now." Laure flung himself into a chair web and regarded the prosaic metal, instruments, manual override controls that surrounded him. "This will do."

"Are you feeling well? Why not go in the diagnoser and let me check you out? We've time before we arrive."

The tone was anxious. Laure didn't believe that emotion was put on. He refrained from anthropomorphizing his computer, just as he did those nonhuman sophonts he encountered. At the same time, he didn't go along with the school of thought which claimed that human-sensibility terms were absolutely meaningless in such connections. An alien brain, or a cybernetic one like *Jaccavrie*'s, could think; it was aware; it had conation. Therefore it had analogies to his.

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Quite a few Rangers were eremitic types, sane enough but basically schizoid. That was their way of standing the gaff. It was normal for them to think of their ships as elaborate tools. Daven Laure, who was young and outgoing, naturally thought of his as a friend.

"No, I'm all right," he said. "A bit nervous, nothing else. This could turn out to be the biggest thing I . . . you and I have tackled yet. Maybe one of the biggest anyone has, at least on this frontier. I'd've been glad to have an older man or two along." He shrugged. "None available. Our service should increase its personnel, even if it means raising dues. We're spread much too thin across—how many stars?"

"The last report in my files estimated ten million planets with a significant number of Commonalty members on them. As for how many more there may be with which these have reasonably regular contact—"

"Oh, for everything's sake, come off it!" Laure actually laughed, and wondered if the ship had planned things that way. But, regardless, he could begin to talk of this as a problem rather than a mystery.

"Let me recapitulate," he said, "and you tell me if I'm misinterpreting matters. A ship comes to Serieve, allegedly from far away. It's like nothing anybody has ever seen, unless in historical works. (They haven't got the references on Serieve to check that out, so we're bringing some from HQ.) Hyperdrive, gravity control, electronics, yes, but everything crude, archaic, bare-bones. Fission instead of fusion power, for example . . . and human piloting!

"That is, the crew seem to be human. We have no record of their anthropometric type, but they don't look as odd as people do after several generations on some planets I could name. And the linguistic computer, once they get the idea that it's there to decipher their language and start cooperating with it, says their speech appears to have remote affinities with a few that we know, like ancient Anglic. Preliminary semantic analysis suggests their abstractions and constructs aren't quite like ours, but do fall well inside the human psych range. All in all, then, you'd assume they're explorers from distant parts."

"Except for the primitive ship," *Jaccavrie* chimed in. "One wouldn't expect such technological backwardness in any group which had maintained any contact, however tenuous, with the general mass of the different human civilizations. Nor would such a slow, under-equipped vessel pass through them without stopping, to fetch up in this border region."

"Right. So . . . if it isn't a fake . . . their gear bears out a part of their story. Kirkasant is an exceedingly old colony . . . yonder." Laure pointed toward unseen stars. "Well out in the Dragon's Head sector, where we're barely beginning

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to explore. Somehow, somebody got that far, and in the earliest days of interstellar travel. They settled down on a planet and lost the trick of making spaceships. Only lately have they regained it."

"And come back, looking for the companionship of their own kind." Laure had a brief, irrational vision of *Jaccavrie* nodding. Her tone was so thoughtful. She would be a big, calm, dark-haired woman, handsome in middle age though getting somewhat plump . . . "What the crew themselves have said, as communication got established, seems to bear out this idea. Beneath a great many confused mythological motifs, I also get the impression of an epic voyage, by a defeated people who ran as far as they could."

"But Kirkasant!" Laure protested. "The whole situation they describe. It's impossible."

"Might not that Vandange be mistaken? I mean, we know so little. The Kirkasanters keep talking about a weird home environment. Ours appears to have stunned and bewildered them. They simply groped on through space till they happened to find Serieve. Thus might their own theory, that somehow they blundered in from an altogether different continuum, might it not conceivably be right?"

"Hm-m-m. I guess you didn't see Vandange's accompanying letter. No, you haven't, it wouldn't've been plugged into your memory. Anyway, he claims his assistants examined that ship down to the bolt heads. And they found nothing, no mechanism, no peculiarity, whose function and behavior weren't obvious. He really gets indignant. Says the notion of inter-space-time transference is mathematically absurd. I don't have quite his faith in mathematics, myself, but I must admit he has one common-sense point. If a ship could, somehow, flip from one entire cosmos to another . . . why, in five thousand years of interstellar travel, haven't we gotten some record of it happening?"

"Perhaps the ships to which it occurs never come back."

"Perhaps. Or perhaps the whole argument is due to misunderstanding. We don't have any good grasp of the Kirkasanter language. Or maybe it's a hoax. That's Vandange's opinion. He claims there's no such region as they say they come from. Not anywhere. Neither astronomers nor explorers have ever found anything like a . . . a space like a shining fog, crowded with stars—"

"But why should these wayfarers tell a falsehood?" *Jaccavrie* sounded honestly puzzled.

"I don't know. Nobody does. That's why the Serievan government decided it'd better ask for a Ranger."

Laure jumped up and started pacing again. He was a tall young man, with the characteristic beardlessness, fair hair and complexion, slightly slanted blue eyes of the Fire-

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land mountaineers on New Vixen. But since he had trained at Starborough, which is on Aladir not far from Irontower City, he affected a fashionably simple gray tunic and blue hose. The silver comet of his calling blazoned his left breast.

"I don't know," he repeated. There rose in him a consciousness of that immensity which crouched beyond this hull. "Maybe they are telling the sober truth. We don't dare not know."

When a few score million people have an entire habitable world to themselves, they do not often build high. That comes later, along with formal wilderness preservation, disapproval of fecundity, and inducements to emigrate. Pioneer towns tend to be low and rambling. (Or so it is in that civilization wherein the Commonalty operates. We know that other branches of humanity have their distinctive ways, and hear rumors of yet stranger ones. But so vast is the galaxy—these two or three spiral arms, a part of which our race has to date thinly occupied —so vast, that we cannot even keep track of our own culture, let alone anyone else's.)

Pelogard, however, was founded on an island off the Branzan mainland, above Serieve's arctic circle: which comes down to almost 56°. Furthermore, it was an industrial center. Hence most of its buildings were tall and crowded. Laure, standing by the outer wall of Ozer Vandange's office and looking forth across the little city, asked why this location had been chosen.

"You don't know?" responded the physicist. His inflection was a touch too elaborately incredulous.

"I'm afraid not," Laure confessed. "Think how many systems my service has to cover, and how many individual places within each system. If we tried to remember each, we'd never be anywhere but under the neuroinductors."

Vandange, seated small and bald and prim behind a large desk, pursed his lips. "Yes, yes," he said. "Nevertheless, I should not think an *experienced* Ranger would dash off to a planet without temporarily mastering a few basic facts about it."

Laure flushed. An experienced Ranger would have put this conceited old dustbrain in his place. But he himself was too aware of youth and awkwardness. He managed to say quietly, "Sir, my ship has complete information. She needed only scan it and tell me no precautions were required here. You have a beautiful globe and I can understand why you're proud of it. But please understand that to me it has to be a way station. My job is with those people from Kirkasant, and I'm anxious to meet them."

"You shall, you shall," said Vandange, somewhat mollified. "I merely thought a conference with you would be advisable first. As for your question, we need a city here primarily because upwelling ocean cur-

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rents make the arctic waters mineral-rich. Extractor plants pay off better than they would further south."

Despite himself, Laure was interested. "You're getting your minerals from the sea already? At so early a stage of settlement?"

"This sun and its planets are poor in heavy metals. Most local systems are. Not surprising. We aren't far, here, from the northern verge of the spiral arm. Beyond is the halo—thin gas, little dust, ancient globular clusters very widely scattered. The interstellar medium from which stars form has not been greatly enriched by earlier generations."

Laure suppressed his resentment at being lectured like a child. Maybe it was just Vandange's habit. He cast another glance through the wall. The office was high in one of the buildings. He looked across soaring blocks of metal, concrete, glass, and plastic, interlinked with trafficways and freight cables, down to the waterfront. There bulked the extractor plants, warehouses, and skydocks. Cargo craft moved ponderously in and out. Not many passenger vessels flitted between. Pelogard must be largely automated.

The season stood at late spring. The sun cast brightness across a gray ocean that a wind rumpled. Immense flocks of seabirds dipped and wheeled. Or were they birds? They had wings, anyhow, steely blue against a wan sky. Perhaps they cried or sang, into the wind skirl and wave rush; but Laure couldn't hear it in this enclosed place.

"That's one reason I can't accept their yarn," Vandange declared.

"Eh?" Laure came out of his reverie with a start.

Vandange pressed a button to opaque the wall. "Sit down. Let's get to business."

Laure eased himself into a lounger opposite the desk. "Why am I conferring with you?" he counterattacked. "Whoever was principally working with the Kirkasanters had to be a semanticist. In short, Paeri Ferand. He consulted specialists on your university faculty, in anthropology, history, and so forth. But I should think your own role as a physicist was marginal. Yet you're the one taking up my time. Why?"

"Oh, you can see Ferand and the others as much as you choose," Vandange said. "You won't get more from them than repetitions of what the Kirkasanters have already told. How could you? What else have they got to go on? If nothing else, an underpopulated world like ours can't maintain staffs of experts to ferret out the meaning of every datum, every inconsistency, every outright lie. I had hoped, when our government notified your sector headquarters, the Rangers would have sent a real team, instead of—" He curbed himself. "Of course, they have many other claims on their attention. They would not see at once how important this is."

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"Well," Laure said in his annoyance, "if you're suspicious, if you think the strangers need further investigation, why bother with my office? It's just an overworked little outpost. Send them on to a heart world, like Sarnac, where the facilities and people really can be had."

"It was urged," Vandange said. "I, and a few others who felt as I do, fought the proposal bitterly. In the end, as a compromise, the government decided to dump the whole problem in the lap of the Rangers. Who turn out to be, in effect, you. Now I must persuade you to be properly cautious. Don't you see, if those . . . beings . . . have some hostile intent, the very worst move would be to send them on—let them spy out our civilization—let them, perhaps, commit nuclear sabotage on a vital center, and then vanish back into space." His voice grew shrill. "That's why we've kept them here so long, on one excuse after the next, here on our home planet. We feel responsible to the rest of mankind!"

"But what—" Laure shook his head. He felt a sense of unreality. "Sir, the League, the troubles, the Empire, its fall, the Long Night . . . every such thing—behind us. In space and time alike. The people of the Commonalty don't get into wars."

"Are you quite certain?"

"What makes *you* so certain of any menace in—one antiquated ship. Crewed by a score of men and women. Who came here openly and peacefully. Who, by every report, have been struggling to get past the language and culture barriers and communicate with you in detail—what in cosmos' name makes you worry about them?"

"The fact that they are liars."

Vandange sat a while, gnawing his thumb, before he opened a box, took out a cigar and puffed it into lighting. He didn't offer Laure one. That might be for fear of poisoning his visitor with whatever local weed he was smoking. Scattered around for many generations on widely differing planets, populations did develop some odd distributions of allergy and immunity. But Laure suspected plain rudeness.

"I thought my letter made it clear," Vandange said. "They insist they are from another continuum. One with impossible properties, including visibility from ours. Conveniently on the far side of the Dragon's Head, so that we don't see it here. Oh, yes," he added quickly, "I've heard the arguments. That the whole thing is a misunderstanding due to our not having an adequate command of their language. That they're really trying to say they came from—well, the commonest rationalization is a dense star cluster. But it won't work, you know. It won't work at all."

"Why not?" Laure asked.

"Come, now. Come, now. You must have learned some astronomy

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as part of your training. You must know that some things simply do not occur in the galaxy."

"Uh—"

"They showed us what they alleged were lens-and-film photographs taken from, ah, inside their home universe." Vandange bore down heavily on the sarcasm. "You saw copies, didn't you? Well, now, where, in the real universe, do you find that kind of nebulosity—so thick and extensive that a ship can actually lose its bearings, wander around lost, using up its film among other supplies, until it chances to emerge in clear space? For that matter, assuming there were such a region, how could anyone capable of building a hyperdrive be so stupid as to go beyond sight of his beacon stars?"

"Uh . . . I thought of a cluster, heavily hazed, somewhat like the young clusters of the Pleiades type."

"So did many Serievans," Vandange snorted. "Please use your head. Not even Pleiadic clusters contain that much gas and dust. Besides, the verbal description of the Kirkasanters sounds like a globular cluster, insofar as it sounds like anything. But not much. The ancient red suns are there, crowded together, true. But they speak of far too many younger ones.

"And of far too much heavy metal at home. Which their ship demonstrates. Their use of alloying elements like aluminum and beryllium is incredibly parsimonious. On the other hand, electrical conductors are gold and silver, the power plant is shielded not with lead but with inert-coated osmium, and it burns plutonium which the Kirkasanters assert was mined!

"They were astonished that Serieve is such a light-metal planet. Or claimed they were astonished. I don't know about that. I do know that this whole region is dominated by light elements. That its interstellar spaces are relatively free of dust and gas, the Dragon's Head being the only exception and it merely in transit through our skies. That all this is even more true of the globular clusters, which formed in an ultra-tenuous medium, mostly before the galaxy had condensed to its present shape—which, in fact, practically don't *occur* in the main body of the galaxy, but are off in the surrounding halo!"

Vandange stopped for breath and triumph.

"Well." Laure shifted uneasily in his seat and wished *Jaccavrie* weren't ten thousand kilometers away at the only spaceport. "You have a point. There are contradictions, aren't there? I'll bear what you said in mind when I, uh, interview the strangers themselves."

"And you will, I trust, be wary of them," Vandange said.

"Oh, yes. Something queer does seem to be going on."

In outward appearance, the Kirkasanters were not startling. They

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didn't resemble any of the human breeds that had developed locally, but they varied less from the norm than some. The fifteen men and five women were tall, robust, broad in chest and shoulders, slim in waist. Their skins were dark coppery reddish, their hair blue-black and wavy; males had some beard and moustache, which they wore neatly trimmed. Skulls were dolichocephalic, faces disharmonically wide, noses straight and thin, lips full. The total effect was handsome. Their eyes were their most arresting feature, large, long-lashed, luminous in shades of gray, or green, or yellow.

Since they had refused—with an adamant politeness they well knew how to assume—to let cell samples be taken for chromosome analysis, Vandange had muttered to Laure about nonhumans in surgical disguise. But that the Ranger classed as the fantasy of a provincial who'd doubtless never met a live xeno. You couldn't fake so many details, not and keep a viable organism. Unless, to be sure, happenstance had duplicated most of those details for you in the course of evolution . . .

Ridiculous, Laure thought. *Coincidence isn't that energetic.*

He walked from Pelogard with Demring Lodden, captain of the *Makt*, and Demring's daughter, navigator Graydal. The town was soon behind them. They found a trail that wound up into steeply rising hills, among low, gnarly trees which had begun to put forth leaves that were fronded and colored like old silver. The sun was sinking, the air noisy and full of salt odors. Neither Kirkasanter appeared to mind the chill.

"You know your way here well," Laure said clumsily.

"We should," Demring answered, "for we have been held on this sole island, with naught to do but ramble it when the *reyad* takes us."

"Reyad?" Laure asked.

"The need to . . . search," Graydal said. "To track beasts, or find what is new, or be alone in wild places. Our folk were hunters until not so long ago. We bear their blood."

Demring wasn't to be diverted from his grudge. "Why are we thus confined?" he growled. "Each time we sought an answer, we got an evasion. Fear of disease, need for us to learn what to expect—Ha, by now I'm half minded to draw my gun, force my way to our ship, and depart for aye!"

He was erect, grizzled, deeply graven of countenance and bleak of gaze. Like his men, he wore soft boots, a knee-length gown of some fine-scaled leather, a cowled cloak, a dagger and an energy pistol at his belt. On his forehead sparkled a diamond that betokened authority.

"Well, but, Master," Graydal said, "here today we deal with no village witchfinders. Daven Laure is a king's man, with power to act, knowledge and courage to act rightly. Has he not gone off alone with us, because you said you felt stifled

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and spied on in the town? Let us talk as freefolk with him."

Her smile, her words in the husky voice that Laure remembered from his recordings, were gentle. He felt pretty sure, though, that as much steel underlay her as her father, and possibly whetted sharper. She almost matched his height, her gait was tigerish, she was herself weaponed and diademmed. Unlike Laure's close cut or Demring's short bob, her hair passed through a platinum ring and blew free at full length. Her clothes were little more than footgear, fringed shorts, and thin blouse. However attractive, the sight did not suggest seductive femininity to the Ranger—when she wasn't feeling the cold that struck through his garments. Besides, he had already learned that the sexes were mixed aboard the *Makt* for no other reason than that women were better at certain jobs than men. Every female was accompanied by an older male relative. The Kirkasanters were not an uncheerful folk, on the whole, but some of their ideals looked austere.

Nonetheless, Graydal had lovely strong features, and her eyes, under the level brows, shone amber.

"Maybe the local government was overcautious," Laure said, "but don't forget, this is a frontier settlement. Not many light-years hence, in that part of the sky you came from, begins the unknown. It's true the stars are comparatively thin in these parts—average distance between them about four parsecs—but still, their number is too great for us to do more than feel our way slowly forward. Especially when, in the nature of the case, planets like Serieve must devote most of their effort to developing themselves. So, when one is ignorant, one does best to be careful."

He flattered himself that was a well-composed conciliatory speech. It wasn't as oratorical as one of theirs, but they had lung capacity for a thinner atmosphere than this. He was disappointed when Demring said scornfully, "*Our* ancestors were not so timid."

"Or else their pursuers were not," Graydal laughed.

The captain looked offended. Laure hastily asked: "Have you no knowledge of what happened?"

"No," said the girl, turned pensive. "Not in truth. Legends, found in many forms across all Kirkasant, tell of battle, and a shipful of people who fled far until at last they found haven. A few fragmentary records —but those are vague, save the Baorn Codex; and it is little more than a compendium of technical information which the Wisemen of Skribent preserved. Even in that case"—she smiled again—"the meaning of most passages was generally obscure until after our modern scientists had invented the thing described for themselves."

"Do you know what records remain in Homeland?" Demring asked hopefully.

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Laure sighed and shook his head. "No. Perhaps none, by now. Doubtless, in time, an expedition will go from us to Earth. But after five thousand trouble-filled years—And your ancestors may not have started from there. They may have belonged to one of the first colonies."

In a dim way, he could reconstruct the story. There had been a fight. The reasons—personal, familial, national, ideological, economic, whatever they were—had dropped into the bottom of the millennia between then and now. (A commentary on the importance of any such reasons.) But someone had so badly wanted the destruction of someone else that one ship, or one fleet, hounded another almost a quarter way around the galaxy.

Or maybe not, in a literal sense. It would have been hard to do.

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Crude as they were, those early vessels could have made the trip, if frequent stops were allowed for repair and resupply and refilling of the nuclear converters. But to this day, a craft under hyperdrive could only be detected within approximately a light-year's radius, by the instantaneous "wake" of space-pulses. If she lay doggo for a while, she was usually unfindable in the sheer stupendousness of any somewhat larger volume. That the hunter should never, in the course of many months, either have overhauled his quarry or lost the scent altogether, seemed conceivable but implausible.

Maybe pursuit had not been for the whole distance. Maybe the refugees had indeed escaped after a while, but—in blind panic or rage against the foe, or desire to practice undisturbed a brand of utopianism, or whatever the motive was—they had continued as far as they possibly could, and hidden themselves as thoroughly as nature allowed.

In any case, they had ended in a strange part of creation: so strange that numerous men on Serieve did not admit it existed. By then, their ship must have been badly in need of a complete overhaul, amounting virtually to a rebuilding. They settled down to construct the necessary industrial base. (Think, for example, how much plant you must have before you make your first transistor.) They did not have the accumulated experience of later generations to prove how impossible this was.

Of course they failed. A few score—a few hundred at absolute maximum, if the ship had been rigged with suspended-animation lockers—could not preserve a full-fledged civilization while coping

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with a planet for which man was never meant. And they had to content themselves with that planet. Once into the Cloud Universe, even if their vessel could still wheeze along for a while, they were no longer able to move freely about, picking and choosing.

Kirkasant was probably the best of a bad lot. And Laure thought it was rather a miracle that man had survived there. So small a genetic pool, so hostile an environment . . . but the latter might well have saved him from the effects of the former. Natural selection must have been harsh. And, seemingly, the radiation background was high, which led to a corresponding mutation rate. Women bore, from puberty to menopause, and buried most of their babies. Men struggled to keep them alive. Often death harvested adults, too, entire families. But those who were fit tended to survive. And the planet did have an unfilled ecological niche: the one reserved for intelligence. Evolution galloped. Population exploded. In one or two millennia, man was at home on Kirkasant. In five, he crowded it and went looking for new planets.

Because culture had never totally died. The first generation might be unable to build machine tools, but could mine and forge metals. The next generation might be too busy to keep public schools, but had enough hard practical respect for learning that it supported a literate class. Succeeding generations, wandering into new lands, founding new nations and societies, might war with each other, but all drew from a common tradition and looked to one goal: reunion with the stars.

Once the scientific method had been created afresh, Laure thought, progress must have been more rapid than on Earth. For the natural philosophers knew certain things were possible, even if they didn't know how, and this was half the battle. They must have got some hints, however oracular, from the remnants of ancient texts. They actually had the corroded hulk of the ancestral ship for their studying. Given this much, it was not too surprising that they leaped in a single lifetime from the first moon rockets to the first hyperdrive craft—and did so on a basis of wildly distorted physical theory, and embarked with such naïveté that they couldn't find their way home again!

All very logical. Unheard of, outrageously improbable, but in this big a galaxy the strangest things are bound to happen now and again. The Kirkasanters could be absolutely honest in their story.

If they were.

"Let the past tend the past," Graydal said impatiently. "We've tomorrow to hunt in."

"Yes," Laure said, "but I do need to know a few things. It's not clear to me how you found us. I mean, you crossed a thousand light-years or more of wilderness. How did you come on a speck like Serieve?"

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"We were asked that before," Demring said, "but then we could not well explain, few words being held in common. Now you show a good command of the Hobrokan tongue, and for our part, albeit none of these villagers will take the responsibility of putting one of us under your educator machine . . . in talking with technical folk we've gained various technical words of yours."

He was silent a while, collecting phrases. The three people continued up the trail. It was wide enough for them to walk abreast, somewhat muddy with rain and melted snow. The sun was so far down that the woods walled it off; twilight smoked from the ground and from either side, though the sky was still pale. The wind was dying but the chill deepening. Somewhere behind those dun trunks and ashy-metallic leaves, a voice went "K-kr-r-r-*ruk!*" and, above and ahead, the sound of a river became audible.

Demring said with care: "See you, when we could not find our way back to Kirkasant's sun, and at last had come out in an altogether different cosmos, we thought our ancestors might have originated there. Certain traditional songs hinted as much, speaking of space as dark, for instance; and surely darkness encompassed us now, and immense loneliness between the stars. Well, but in which direction might Homeland lie? Casting about with telescopes, we spied afar a black cloud, and thought, if the ancestors had been in flight from enemies, they might well have gone through such, hoping to break their trail."

"The Dragon's Head Nebula," Laure nodded.

Graydal's wide shoulders lifted and fell. "At least it gave us something to steer by," she said.

Laure stole a moment's admiration of her profile. "You had courage," he said. "Quite aside from everything else, how did you know this civilization had not stayed hostile to you?"

"How did we know it ever was in the first place?" she chuckled. "Myself, insofar as I believe the myths have any truth, I suspect our ancestors were thieves, or bandits, or—"

"Daughter!" Demring hurried on, in a scandalized voice: "When we had fared thus far, we found the darkness was dust and gas such as pervade the universe at home. There was simply an absence of stars to make it shine. Emerging on the far side, we tuned our neutrino detectors. Our reasoning was that a highly developed civilization would use a great many nuclear power plants. Their neutrino flux should be detectable above the natural noise level—in this comparatively empty cosmos—across several score light-years or better, and we could home on it."

First they sound like barbarian bards, Laure thought, *and then like radionicians. No wonder a dogma-*

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tist like Vandange can't put credence in them.

Can I?

"We soon began to despair," Graydal said. "We were nigh to the limit—"

"No matter," Demring interrupted.

She looked steadily first at one man, then the other, and said, "I dare trust Daven Laure." To the Ranger: "Belike no secret anyhow, since men on Serieve must have examined our ship with knowledgeable eyes. We were nigh to our limit of travel without refueling and refurbishing. We were about to seek for a planet not too unlike Kirkasant where—But then, as if by Valfar's Wings, came the traces we sought, and we followed them here.

"And here were humans!

"Only of late has our gladness faded, as we begin to see how they temporize and keep us half prisoner. Wholly prisoner, maybe, should we try to depart. Why will they not rely on us?"

"I tried to explain that when we talked yesterday," Laure said. "Some important men don't see how you could be telling the truth."

She caught his hand in a brief, impulsive grasp. Her own was warm, slender, and hard. "But you are different?"

"Yes." He felt helpless and alone. "They've, well, they've called for me. Put the entire problem in the hands of my organization. And my fellows have so much else to do that, well, I'm given broad discretion."

Demring regarded him shrewdly. "You are a young man," he said. "Do not let your powers paralyze you."

"No. I will do what I can for you. It may be little."

The trail rounded a thicket and they saw a rustic bridge across the river, which ran seaward in foam and clangor. Halfway over, the party stopped, leaned on the rail and looked down. The water was thickly shadowed between its banks, and the woods were becoming a solid black mass athwart a dusking sky. The air smelled wet.

"You realize," Laure said, "it won't be easy to retrace your route. You improvised your navigational coordinates. They can be transformed into ours on this side of the Dragon's Head, I suppose. But once beyond the nebula, I'll be off my own charts, except for what few listed objects are visible from either side. No one from this civilization has been there, you see, what with millions of suns closer to our settlements. And the star sights you took can't have been too accurate."

"You are not going to take us to Homeland, then," Demring said tonelessly.

"Don't you understand? Homeland, Earth, it's so far away that I myself don't know what it's like any more!"

"But you must have a nearby

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capital, a more developed world than this. Why do you not guide us thither, that we may talk with folk wiser than these wretched Sievans?"

"Well . . . uh . . . Oh, many reasons. I'll be honest, caution is one of them. Also, the Commonalty does not have anything like a capital, or —But yes, I could guide you to the heart of civilization. Any of numerous civilizations in this galactic arm." Laure took a breath and slogged on. "My decision, though, under the circumstances, is that first I'd better see your world. Kirkasant. After that . . . well, certainly, if everything is all right, we'll establish regular contacts, and invite your people to visit ours, and— Don't you like the plan? Don't you want to go home?"

"How shall we, ever?" Graydal asked low.

Laure cast her a surprised glance. She stared ahead of her and down, into the river. A fish—some kind of swimming creature—leaped. Its scales caught what light remained in a gleam that was faint but startling against those murky waters. She didn't seem to notice, though she cocked her head instinctively toward the splash that followed.

"Have you not listened?" she said. "Did you not hear us? How long we searched in the fog, through that forest of suns, until at last we left our whole small bright universe and came into this great one that has so much blackness in it—and thrice we plunged back into our own space, and groped about, and came forth without having found trace of any star we knew—" Her voice lifted the least bit. "We are lost, I tell you, eternally lost. Take us to your home, Daven Laure, that we may try to make ours there."

He wanted to stroke her hands, which had clenched into fists on the bridge rail. But he made himself say only: "Our science and resources are more than yours. Maybe we can find a way where you cannot. At any rate, I'm duty bound to learn as much as I can, before I make report and recommendation to my superiors."

"I do not think you are kind, forcing my crew to return and look again on what has gone from them," Demring said stiffly. "But I have scant choice save to agree." He straightened. "Come, best we start back toward Pelogard. Night will soon be upon us."

"Oh, no rush," Laure said, anxious to change the subject. "An arctic zone, at this time of year—We'll have no trouble."

"Maybe you will not," Graydal said. "But Kirkasant after sunset is not like here."

They were on their way down when dusk became night, a light night where only a few stars gleamed and Laure walked easily through a clear gloaming. Graydal and Demring must needs use their

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energy guns at minimum intensity for flashcasters. And even so, they often stumbled.

Makt was three times the size of *Jaccavrie,* a gleaming torpedo shape whose curve was broken by boat housings and weapon turrets. The Ranger vessel looked like a gig attending her. In actuality, *Jaccavrie* could have outrun, outmaneuvered, or outfought the Kirkasanter with ludicrous ease. Laure didn't emphasize that fact. His charges were touchy enough already. He had suggested hiring a modern carrier for them, and met a glacial negative. This craft was the property and bore the honor of the confederated clans that had built her. She was not to be abandoned.

Modernizing her would have taken more time than increased speed would save. Besides, while Laure was personally convinced of the good intentions of Demring's people, he had no right to present them with up-to-date technology until he had proof they wouldn't misuse it.

One could not accurately say that he resigned himself to accompanying them in his ship at the plodding pace of theirs. The weeks of travel gave him a chance to get acquainted with them and their culture. And that was not only his duty but his pleasure. Especially, he found, when Graydal was involved.

Some time passed before he could invite her to dinner *à deux.* He arranged it with what he felt sure was adroitness. Two persons, undisturbed, talking socially, could exchange information of the subtle kind that didn't come across in committee. Thus he proposed a series of private meetings with the officers of *Makt.* He began with the captain, naturally; but after a while came the navigator's turn.

Jaccavrie phased in with the other vessel, laid alongside and made air-lock connections in a motion too smooth to feel. Graydal came aboard and the ships parted company again. Laure greeted her according to the way of Kirkasant, with a handshake. The clasp lasted a moment. "Welcome," he said.

"Peace between us." Her smile offset her formalism. She was in uniform—another obsolete aspect of her society—but it shimmered gold and molded itself to her.

"Won't you come to the saloon for a drink before we eat?"

"I shouldn't. Not in space."

"No hazard," said the computer in an amused tone. "I operate everything anyway."

Graydal had tensed and clapped hand to gun at the voice. She relaxed and tried to laugh. "I'm sorry. I am not used to . . . you." She almost bounded on her way down the corridor with Laure. He had set the interior weight at one standard G. The Kirkasanters maintained theirs fourteen percent higher, to match the pull of their home world.

Though she had inspected this

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ship several times already, Graydal looked wide-eyed around her. The saloon was small but sybaritic. "You do yourself proud," she said amidst the draperies, music, perfumes, and animations.

He guided her to a couch. "You don't sound quite approving," he said.

"Well—"

"There's no virtue in suffering hardships."

"But there is in the ability to endure them." She sat too straight for the form-fitter cells to make her comfortable.

"Think I can't?"

Embarrassed, she turned her gaze from him, toward the viewscreen, on which flowed a color composition. Her lips tightened. "Why have you turned off the exterior scene?"

"You don't seem to like it, I've noticed." He sat down beside her. "What will you have? We're fairly well stocked."

"Turn it on."

"What?"

"The outside view." Her nostrils dilated. "It shall not best me."

He spread his hands. The ship saw his rueful gesture and obliged. Space leaped into the screen, starstrewn except where the stormcloud mass of the dark nebula reared ahead. He heard Graydal suck in a breath and said quickly, "Uh, since you aren't familiar with our beverages, I suggest daiquiris. They're tart, a little sweet—"

Her nod was jerky. Her eyes seemed locked to the screen. He leaned close, catching the slight warm odor of her, not quite identical with the odor of other women he had known, though the difference was too subtle for him to name. "Why does that sight bother you?" he asked.

"The strangeness. The aloneness. It is so absolutely alien to home. I feel forsaken and—" She filled her lungs, forced detachment on herself, and said in an analytical manner: "Possibly we are disturbed by a black sky because we have virtually none of what you call night vision." A touch of trouble returned. "What else have we lost?"

"Night vision isn't needed on Kirkasant, you tell me," Laure consoled her. "And evolution there worked fast. But you must have gained as well as atrophied. I know you have more physical strength, for instance, than your ancestors could've had." A tray with two glasses extended from the side. "Ah, here are the drinks."

She sniffed at hers. "It smells pleasant," she said. "But are you sure there isn't something I might be allergic to?"

"I doubt that. You didn't react to anything you tried on Serieve, did you?"

"No, except for finding it overly bland."

"Don't worry," he grinned. "Before we left, your father took care to present me with one of your salt-

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shakers. It'll be on the dinner table."

Jaccavrie had analyzed the contents. Besides sodium and potassium chloride—noticeably less abundant on Kirkasant than on the average planet, but not scarce enough to cause real trouble—the mixture included a number of other salts. The proportion of rare earths and, especially, arsenic was surprising. An ordinary human who ingested the latter element at that rate would lose quite a few years of life expectancy. Doubtless the first refugee generations had, too, when something else didn't get them first. But by now their descendants were so well adapted that food didn't taste right without a bit of arsenic trioxide.

"We wouldn't have to be cautious—we'd know in advance what you can and cannot take—if you'd permit a chromosome analysis," Laure hinted. "The laboratory aboard this ship can do it."

Her cheeks turned more than ever coppery. She scowled. "We refused before," she said.

"May I ask why?"

"It . . . violates integrity. Humans are not to be probed into."

He had encountered that attitude before, in several guises. To the Kirkasanter—at least, to the Hobrokan clansman; the planet had other cultures—the body was a citadel for the ego, which by right should be inviolable. The feeling, so basic that few were aware of having it, had led to the formation of reserved, often rather cold personalities. It had handicapped if not stopped the progress of medicine. On the plus side, it had made for dignity and self-reliance; and it had caused this civilization to be spared professional gossips, confessional literature, and psychoanalysis.

"I don't agree," Laure said. "Nothing more is involved than scientific information. What's personal about a DNA map?"

"Well . . . maybe. I shall think on the matter." Graydal made an obvious effort to get away from the topic. She sipped her drink, smiled, and said, "Mm-m-m, this *is* a noble flavor."

"Hoped you'd like it. I do. We have a custom in the Commonalty —" He touched glasses with her.

"Charming. Now we, when good friends are together, drink half what's in our cups and then exchange them."

"May I?"

She blushed again, but with pleasure. "Certainly. You honor me."

"No, the honor is mine." Laure went on, quite sincere: "What your people have done is tremendous. What an addition to the race you'll be!"

Her mouth drooped. "If ever my folk may be found."

"Surely—"

"Do you think we did not try?" She tossed off another gulp of her

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cocktail. Evidently it went fast to her unaccustomed head. "We did not fare forth blindly. Understand that, *Makt* is not the first ship to leave Kirkasant's sun. But the prior ones went to nearby stars, stars that can be seen from home. They are many. We had not realized how many more are in the Cloud Universe, hidden from eyes and instruments, a few light-years further on. We, our ship, we intended to take the next step. Only the next step. Barely beyond that shell of suns we could see from Kirkasant's system. We could find our way home again without trouble. Of course we could! We need but steer by those suns that were already charted on the edge of instrumental perception. Once we were in their neighborhood, our familiar part of space would be visible."

She faced him, gripping his arm painfully hard, speaking in a desperate voice. "What we had not known, what no one had known, was the imprecision of that charting. The absolute magnitudes, therefore the distances and relative positions of those verge-visible stars . . . had not been determined as well as the astronomers believed. Too much haze, too much shine, too much variability. Do you understand? And so, suddenly, our tables were worthless. We thought we could identify some suns. But we were wrong. Flitting toward them, we must have bypassed the volume of space we sought . . . and gone on and on, more hopelessly lost each day, each endless day—

"What makes you think you can find our home?"

Laure, who had heard the details before, had spent the time admiring her and weighing his reply. He sipped his own drink, letting the sourness glide over his palate and the alcohol slightly, soothingly burn him, before he said: "I can try. I do have instruments your people have not yet invented. Inertial devices, for example, that work under hyperdrive as well as at true velocity. Don't give up hope." He paused. "I grant you, we might fail. Then what will you do?"

The blunt question, which would have driven many women of his world to tears, made her rally. She lifted her head and said—haughtiness rang through the words: "Why, we will make the best of things, and I do not think we will do badly."

Well, he thought, *she's descended from nothing but survivor types. Her nature is to face trouble and whip it.*

"I'm sure you will succeed magnificently," he said. "You'll need time to grow used to our ways, and you may never feel quite easy in them, but—"

"What are your marriages like?" she asked.

"Uh?" Laure fitted his jaw back into place.

She was not drunk, he decided. A bit of drink, together with these

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surroundings, the lilting music, odors and pheromones in the air, had simply lowered her inhibitions. The huntress in her was set free, and at once attacked whatever had been most deeply perturbing her. The basic reticence remained. She looked straight at him, but she was fiery-faced, as she said:

"We ought to have had an equal number of men and women along on *Makt*. Had we known what was to happen, we would have done so. But now ten men shall have to find wives among foreigners. Do you think they will have much difficulty?"

"Uh, why no. I shouldn't think they will," he floundered. "They're obviously superior types, and then, being exotic—glamorous . . ."

"I speak not of amatory pleasure. But . . . what I overheard on Serieve, a time or two . . . did I miscomprehend? Are there truly women among you who do not bear children?"

"On the older planets, yes, that's not uncommon. Population control—"

"We shall have to stay on Serieve, then, or worlds like it." She sighed. "I had hoped we might go to the pivot of your civilization, where your real work is done and our children might become great."

Laure considered her. After a moment, he understood. Adapting to the uncountably many alienness-es of Kirkasant had been a long and cruel process. No blood line survived which did not do more than make up its own heavy losses. The will to reproduce was a requirement of existence. It, too, became an instinct.

He remembered that, while Kirkasant was not a very fertile planet, and today its population strained its resources, no one had considered reducing the birthrate. When someone on Serieve had asked why, Demring's folk had reacted strongly. The idea struck them as obscene. They didn't care for the notion of genetic modification or exogenetic growth, either. And yet they were quite reasonable and noncompulsive about most other aspects of their culture.

Culture, Laure thought. *Yes. That's mutable. But you don't change your instincts; they're built into your chromosomes. Her people* must *have children.*

"Well," he said, "you can find women who want large families on the central planets, too. If anything, they'll be eager to marry your friends. They have a problem finding men who feel as they do, you see."

Graydal dazzled him with a smile and held out her glass. "Exchange?" she proposed.

"Hoy, you're way ahead of me." He evened the liquid levels. "Now."

They looked at each other throughout the little ceremony. He nerved himself to ask, "As for you women, do you necessarily have to marry within your ship?"

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"No," she said. "It would depend on . . . whether any of your folk . . . might come to care for one of us."

"That I can guarantee!"

"I would like a man who travels," she murmured, "if I and the children could come along."

"Quite easy to arrange," Laure said.

She said in haste: "But we are buying grief, are we not? You told me perhaps you can find our planet for us."

"Yes. I hope, though, if we succeed, that won't be the last I see of you."

"Truly it won't."

They finished their drinks and went to dinner. *Jaccavrie* was also an excellent cook. And the choice of wines was considerable. What was said and laughed at over the table had no relevance to anyone but Laure and Graydal.

Except that, at the end, with immense and tender seriousness, she said: "If you want a cell sample from me . . . for analysis . . . you may have it."

He reached across the table and took her hand. "I wouldn't want you to do anything you might regret later," he said.

She shook her head. The tawny eyes never left him. Her voice was slow, faintly slurred, but bespoke complete awareness of what she was saying. "I have come to know you. For you to do this thing will be no violation."

Laure explained eagerly: "The process is simple and painless, as far as you're concerned. We can go right down to the lab. The computer operates everything. It'll give you an anesthetic spray and remove a small sample of flesh, so small that tomorrow you won't be sure where the spot was. Of course, the analysis will take a long while. We don't have all possible equipment aboard. And the computer does have to devote most of her—most of its attention to piloting and interior work. But at the end, we'll be able to tell you—"

"Hush." Her smile was sleepy. "No matter. If you wish this, that's enough. I ask only one thing."

"What?"

"Do not let a machine use the knife, or the needle, or whatever it is. I want you to do that, yourself."

". . . Yes. Yonder is our home sky." The physicist Hirn Oran's son spoke slow and hushed. Cosmic interference seethed across his radio voice, nigh drowning it in Laure's and Graydal's earplugs.

"No," the Ranger said. "Not off there. We're already in it."

"What?" Silvery against rock, the two space-armored figures turned to stare at him. He could not see their expressions behind the faceplates, but he could imagine how astonishment flickered above awe.

He paused, arranging words in his mind. The star noise in his receivers was like surf and fire. The landscape overwhelmed him.

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Here was no simple airless planet. No planet is ever really simple, and this one had a stranger history than most. Eons ago it was apparently a subjovian, with a cloudy hydrohelium and methane atmosphere and an immense shell of ice and frozen gases around the core; for it orbited its sun at a distance of almost a billion and a half kilometers, and though that primary was bright, at this remove it could be little more than a spark.

Until stellar evolution—hastened, Laure believed, by an abnormal infall of cosmic material—took the star off the main sequence. It swelled, surface cooling to red but total output growing so monstrous that the inner planets were consumed. On the farther ones, like this, atmosphere fled into space. Ice melted; the world-ocean boiled; each time the pulsations of the sun reached a maximum, more vapor escaped. Now nothing remained except a ball of metal and rock, hardly larger than a terrestrial-type globe. As the pressure of the top layers was removed, frightful tectonic forces must have been liberated. Mountains—the younger ones with crags like sharp teeth, the older ones worn by meteorite and thermal erosion—rose from a cratered plain of gloomy stone. Currently at a minimum, but nonetheless immense, a full seven degrees across, blue core surrounded and dimmed by the tenuous ruddy atmosphere, the sun smoldered aloft.

Its furnace light was not the sole illumination. Another star was passing sufficiently near at the time that it showed a perceptible disk . . . in a stopped-down viewscreen, because no human eye could directly confront that electric cerulean intensity. The outsider was a B_8, newborn out of dust and gas, blazing with an intrinsic radiance of a hundred Sols.

Neither one helped in the shadows cast by the pinnacled upthrust which Laure's party was investigating. Flashcasters were necessary.

But more was to see overhead, astride the dark. Stars in thousands powdered the sky, brilliant with proximity. And they were the mere fringes of the cluster. It was rising as the planet turned, partly backgrounding and partly following the sun. Laure had never met a sight to compare. For the most part, the individuals he could pick out in that enormous spheroidal cloud of light were themselves red: long-lived dwarfs, dying giants like the one that brooded over him. But many glistened exuberant golden, emerald, sapphire. Some could not be older than the blue which wandered past and added its own harsh hue to this land. All those stars were studded through a soft glow that pervaded the entire cluster, a nacreous luminosity into which they faded and vanished, the fog wherein his companions had lost their home but which was a shining beauty to behold.

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"You live in a wonder," Laure said.

Graydal moved toward him. She had had no logical reason to come down out of *Makt*'s orbit with him and Hirn. The idea was simply to break out certain large ground-based instruments that *Jaccavrie* carried, for study of their goal before traveling on. Any third party could assist. But she had laid her claim first, and none of her shipmates argued. They knew how often she and Laure were in each other's company.

"Wait until you reach our world," she said low. "Space is eldritch and dangerous. But once on Kirkasant— We will watch the sun go down in the Rainbow Desert; suddenly, in that thin air, night has come, our shimmering star-crowded night, and the auroras dance and whisper above the stark hills. We will see great flying flocks rise from dawn mists over the salt marshes, hear their wings thunder and their voices flute. We will stand on the battlements of Ey, under the banners of those very knights who long ago rid the land of the fire-garms, and watch the folk dance welcome to a new year—"

"If the navigator pleases," said Hirn, his voice sharpened by an unadmitted dauntlessness, "we will save our dreams for later and attend now to the means of realizing them. At present, we are supposed to choose a good level site for the observing apparatus. But, ah, Ranger Laure, may I ask what you meant by saying we are already back in the Cloud Universe?"

Laure was not as annoyed to have Graydal interrupted as he might normally have been. She'd spoken of Kirkasant so often that he felt he had almost been there himself. Doubtless it had its glories, but by his standards it was a grim, dry, storm-scoured planet where he would not care to stay for long at a time. Of course, to her it was beloved home; and he wouldn't mind making occasional visits if— No, chaos take it, there was work on hand!

Part of his job was to make explanations. He said: "In your sense of the term, Physicist Hirn, the Cloud Universe does not exist."

The reply was curt through the static. "I disputed that point on Serieve already, with Vandange and others. And I resented their implication that we of *Makt* were either liars or incompetent observers."

"You're neither," Laure said quickly. "But communication had a double barrier on Serieve. First, an imperfect command of your language. Only on the way here, spending most of my time in contact with your crew, have I myself begun to feel a real mastery of Hobrokan. The second barrier, though, was in some ways more serious: Vandange's stubborn preconceptions, and your own."

"I was willing to be convinced."

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"But you never got a convincing argument. Vandange was so dogmatically certain that what you reported having seen was impossible, that he didn't take a serious look at your report to see if it might have an orthodox explanation after all. You naturally got angry at this and cut the discussions off short. For your part, you had what you had always been taught was a perfectly good theory, which your experiences had confirmed. You weren't going to change your whole concept of physics just because the unlovable Ozer Vandange scoffed at it."

"But we were mistaken," Graydal said. "You've intimated as much, Daven, but never made your meaning clear."

"I wanted to see the actual phenomenon for myself, first," Laure said. "We have a proverb—so old that it's reputed to have originated on Earth—'It is a capital mistake to theorize in advance of the data.' But I couldn't help speculating, and what I see shows my speculations were along the right lines."

"Well?" Hirn challenged.

"Let's start with looking at the situation from your viewpoint," Laure suggested. "Your people spent millennia on Kirkasant. You lost every hint, except a few ambiguous traditions, that things might be different elsewhere. To you, it was natural that the night sky should be like a gently shining mist, and stars should crowd thickly around. When you developed the scientific method again, not many generations back, perforce you studied the universe you knew. Ordinary physics and chemistry, even atomistics and quantum theory, gave you no special problems. But you measured the distances of the visible stars as light-months—at most, a few light-years—after which they vanished in the foggy background. You measured the concentration of that fog, that dust and fluorescing gas. And you had no reason to suppose the interstellar medium was not equally dense everywhere. Nor had you any hint of receding galaxies.

"So your version of relativity made space sharply curved by the mass packed together throughout it. The entire universe was two or three hundred light-years across. Stars condensed and evolved—you could witness every stage of that—but in a chaotic fashion, with no particular overall structure. It's a wonder to me that you went on to gravitics and hyperdrive. I wish I were scientist enough to appreciate how different some of the laws and constants must be in your physics. But you did plow ahead. I guess the fact you knew these things were possible was important to your success. Your scientists would keep fudging and finagling, in defiance of theoretical niceties, until they made something work."

"Um-m-m . . . as a matter of fact, yes," Hirn said in a slightly abashed tone. Graydal snickered.

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"Well, then *Makt* lost her way, and emerged into the outer universe, which was totally strange," Laure said. "You had to account somehow for what you saw. Like any scientists, you stayed with accepted ideas as long as feasible—a perfectly correct principle which my people call the razor of Occam. I imagine that the notion of contiguous space-times with varying properties looks quite logical if you're used to thinking of a universe with an extremely small radius. You may have been puzzled as to how you managed to get out of one 'bubble' and into the next, but I daresay you cobbled together a tentative explanation."

"I did," Hirn said. "If we postulate a multi-dimensional—"

"Never mind," Laure said. "That's no longer needful. We can account for the facts much more simply."

"How? I have been pondering it. I think I can grasp the idea of a universe billions of light-years across, in which the stars form galaxies. But our home space—"

"Is a dense star cluster. And as such, it has no definite boundaries. That's what I meant by saying we are already in it. In the thin verge, at least." Laure pointed to the diffuse, jeweled magnificence that was rising higher above these wastes, in the wake of the red and blue suns. "Yonder's the main body, and Kirkasant is somewhere there. But this system here is associated. I've checked proper motions and I know."

"I could have accepted some such picture while on Serieve," Hirn said. "But Vandange was so insistent that a star cluster like this cannot be." Laure visualized the sneer behind his faceplate. "I thought that he, belonging to the master civilization, would know whereof he spoke."

"He does. He's merely rather unimaginative," Laure said. "You see, what we have here is a globular cluster. That's a group made up of stars close together in a roughly spherical volume of space. I'd guess you have a quarter million, packed into a couple of hundred light-years' diameter.

"But globular clusters haven't been known like this one. The ones we do know lie mostly well off the galactic plane. The space within them is much clearer than in the spiral arms, almost a perfect vacuum. The individual members are red. Any normal stars of greater than minimal mass have gone off the main sequence long ago. The survivors are metal-poor. That's another sign of extreme age. Heavy elements are formed in stellar cores, you know, and spewed back into space. So it's the younger suns, coalescing out of the enriched interstellar medium, that contain a lot of metal. All in all, everything points to the globular clusters being relics of an embryo stage in the galaxy's life.

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"Yours, however—! Dust and gas so thick that not even a giant can be seen across many parsecs. Plenty of main-sequence stars, including blues which cannot be more than a few million years old, they burn out so fast. Spectra, not to mention planets your explorers visited, showing atomic abundances far skewed toward the high end of the periodic table. A background radiation too powerful for a man like me to dare take up permanent residence in your country.

"Such a cluster shouldn't be!"

"But it is," Graydal said.

Laure made bold to squeeze her hand, though little of that could pass through the gauntlets. "I'm glad," he answered.

"How do you explain the phenomenon?" Hirn asked.

"Oh, that's obvious . . . now that I've seen the thing and gathered some information on its path," Laure said. "An improbable situation, maybe unique, but not impossible. This cluster happens to have an extremely eccentric orbit around the galactic center of mass. Once or twice a gigayear, it passes through the vast, thick clouds that surround that region. By gravitation, it sweeps up immense quantities of stuff. Meanwhile, I suppose, perturbation causes some of its senior members to drift off. You might say it's periodically rejuvenated.

"At present, it's on its way out again. Hasn't quite left our spiral arm. It passed near the galactic midpoint just a short while back, cosmically speaking; I'd estimate less than fifty million years. The infall is still turbulent, still condensing out into new stars like that blue giant shining on us. Your home sun and its planets must be a product of an earlier sweep. But there've been twenty or thirty such since the galaxy formed, and each one of them was responsible for several generations of giant stars. So Kirkasant has a lot more heavy elements than the normal planet, even though it's not much younger than Earth. Do you follow me?"

"Hm-m-m . . . perhaps. I shall have to think." Hirn walked off, across the great tilted block on which the party stood, to its edge, where he stopped and looked down into the shadows below. They were deep and knife sharp. The mingled light of red and blue suns, stars, starfog played eerie across the stone land. Laure grew aware of what strangenesses and what silence—under the hiss in his ears—pressed in on him.

Graydal must have felt the same, for she edged close until their armors clinked together. He would have liked to see her face. She said: "Do you truly believe we can enter that realm and conquer it?"

"I don't know," he said, slow and blunt. "The sheer number of stars may beat us."

"A large enough fleet could search them, one by one."

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"If it could navigate. We have yet to find out whether that's possible."

"Suppose. Did you guess a quarter million suns in the cluster? Not all are like ours. Not even a majority. On the other coin-side, with visibility as low as it is, space must be searched back and forth, light-year by light-year. We of *Makt* could die of eld before a single vessel chanced on Kirkasant."

"I'm afraid that's true."

"Yet an adequate number of ships, dividing the task, could find our home in a year or two."

"That would be unattainably expensive, Graydal."

He thought he sensed her stiffening. "I've come on this before," she said coldly, withdrawing from his touch. "In your Commonalty they count the cost and the profit first. Honor, adventure, simple charity must run a poor second."

"Be reasonable," he said. "Cost represents labor, skill, and resources. The gigantic fleet that would go looking for Kirkasant must be diverted from other jobs. Other people would suffer need as a result. Some might suffer sharply."

"Do you mean a civilization as big, as productive as yours could not spare that much effort for a while without risking disaster?"

She's quick on the uptake, Laure thought. *Knowing what machine technology can do on her single impoverished world, she can well guess what it's capable of with millions of planets to draw on. But how can I make her realize that matters aren't that simple?*

"Please, Graydal," he said. "Won't you believe I'm working for you? I've come this far, and I'll go as much further as need be, if something doesn't kill us."

He heard her gulp. "Yes. I offer apology. *You* are different."

"Not really. I'm a typical Commonalty member. Later, maybe, I can show you how our civilization works, and what an odd problem in political economy we've got if Kirkasant is to be rediscovered. But first we have to establish that locating it is physically possible. We have to make long-range observations from here, and then enter those mists, and —One trouble at a time, I beg you!"

She laughed gently. "Indeed, my friend. And you will find a way." The mirth faded. It had never been strong. "Won't you?" The reflection of clouded stars glistened on her faceplate like tears.

Blindness was not dark. It shone.

Standing on the bridge, amidst the view of space, Laure saw nimbus and thunderheads. They piled in cliffs, they eddied and streamed, their color was a sheen of all colors overlying white—mother-of-pearl —but here and there they darkened with shadows and grottoes; here and there they glowed dull red as they reflected a nearby sun. For the stars were scattered about in their

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myriads, dominantly ruby and ember, some yellow or candent, green or blue. The nearest were clear to the eye, a few showing tiny disks, but the majority were fuzzy glows rather than light-points. Such shimmers grew dim with distance until the midst engulfed them entirely and nothing remained but mist.

A crackling noise beat out of that roiling formlessness, like flames. Energies pulsed through his marrow. He remembered the old, old myth of the Yawning Gap, where fire and ice arose and out of them the Nine Worlds, which were doomed in the end to return to fire and ice; and he shivered.

"Illusion," said *Jaccavrie*'s voice out of immensity.

"What?" Laure started. It was as if a mother goddess had spoken.

She chuckled. Whether deity or machine, she had the great strength of ordinariness in her. "You're rather transparent to an observer who knows you well," she said. "I could practically read your mind."

Laure swallowed. "The sight, well, a big, marvelous, dangerous thing, maybe unique in the galaxy. Yes, I admit I'm impressed."

"We have much to learn here."

"Have you been doing so?"

"At a near-capacity rate, since we entered the denser part of the cluster." *Jaccavrie* shifted to primness. "If you'd been less immersed in discussions with the Kirkasanter navigation officer, you might have got running reports from me."

"Destruction!" Laure swore. "I was studying her notes from their trip outbound, trying to get some idea of what configuration to look for, once we've learned how to make allowance for what this material does to starlight—Never mind. We'll have our conference right now, just as you requested. What'd you mean by 'an illusion'?"

"The view outside," answered the computer. "The concentration of mass is not really as many atoms per cubic centimeter as would be found in a vaporous planetary atmosphere. It is only that, across light-years, their absorption and reflection effects are cumulative. The gas and dust does, indeed, swirl, but not with anything like the velocity we think we perceive. That is due to our being under hyperdrive. Even at the very low pseudospeed at which we are feeling our way, we pass swiftly through varying densities. Space itself is not actually shining; excited atoms are fluorescing. Nor does space roar at you. What you hear is the sound of radiation counters and other instruments which I've activated. There are no real, tangible currents working on our hull, making it quiver. But when we make quantum microjumps across strong interstellar magnetic fields, and those fields vary according to an extraordinarily complex pattern, we're bound to interact noticeably with them.

"Admittedly the stars are far thicker than appears. My instru-

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ments can detect none beyond a few parsecs. But what data I've gathered of late leads me to suspect the estimate of a quarter million total is conservative. To be sure, most are dwarfs—"

"Come off that!" Laure barked. "I don't need you to explain what I knew the minute I saw this place."

"You need to be drawn out of your fantasizing," *Jaccavrie* said. "Though you recognize your daydreams for what they are, you can't afford them. Not now."

Laure tensed. He wanted to order the view turned off, but checked himself, wondered if the robot followed that chain of his impulses too, and said in a harshened voice: "When you go academic on me like that, it means you're postponing news you don't want to give me. We have troubles."

"We can soon have them, at any rate," *Jaccavrie* said. "My advice is to turn back at once."

"We can't navigate," Laure deduced. Though it was not unexpected, he nonetheless felt smitten.

"No. That is, I'm having difficulties already, and conditions ahead of us are demonstrably worse."

"What's the matter?"

"Optical methods are quite unsuitable. We knew that from the experience of the Kirkasanters. But nothing else works either. You recall, you and I discussed the possibility of identifying supergiant stars through the clouds and using them for beacons. Though their light be diffused and absorbed, they should produce other effects—they should be powerful neutrino sources, for instance—that we could use."

"Don't they?"

"Oh, yes. But the effects are soon smothered. Too much else is going on. Too many neutrinos from too many different sources, to name one thing. Too many magnetic effects. The stars are so close together, you see; and so many of them are double, triple, quadruple, hence revolving rapidly and twisting the force lines; and irradiation keeps a goodly fraction of the interstellar medium in the plasma state. Thus we get electromagnetic action of every sort, plus synchrotron and betatron radiation, plus nuclear collisions, plus—"

"Spare me the complete list," Laure broke in. "Just say the noise level is too high for your instruments."

"And for any instruments that I can extrapolate as buildable," *Jaccavrie* replied. "The precision their filters would require seems greater than the laws of atomistics would allow."

"What about your inertial system? Bollixed up, too?"

"It's beginning to be. That's why I asked you to come take a good look at what's around us and what we're headed into, while you listen to my report." The robot was not built to know fear, but Laure wondered if she didn't spring back to

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pedantry as a refuge: "Inertial navigation would work here at kinetic velocities. But we can't traverse parsecs except under hyperdrive. Inertial and gravitational mass being identical, too rapid a change of gravitational potential will tend to cause uncontrollable precession and nutation. We can compensate for that in normal parts of space. But not here. With so many stars so closely packed, moving among each other on paths too complex for me to calculate, the variation rate is becoming too much."

"In short," Laure said slowly, "if we go deeper into this stuff, we'll be flying blind."

"Yes. Just as *Makt* did."

"We can get out into clear space any time, can't we? You can follow a more or less straight line till we emerge."

"True. I don't like the hazards. The cosmic ray background is increasing considerably."

"You have screen fields."

"But I'm considering the implications. Those particles have to originate somewhere. Magnetic acceleration will only account for a fraction of their intensity. Hence the rate of nova production in this cluster, and of supernovae in the recent past, must be enormous. This in turn indicates vast numbers of lesser bodies—neutron stars, rogue planets, large meteoroids, thick dust banks —things that might be undetectable before we blunder into them."

Laure smiled at her unseen scanner. "If anything goes wrong, you'll react fast," he said. "You always do."

"I can't guarantee we won't run into trouble I can't deal with."

"Can you estimate the odds on that for me?"

Jaccavrie was silent. The air sputtered and sibilated. Laure found his vision drowning in the starfog. He needed a minute to realize he had not been answered. "Well?" he said.

"The parameters are too uncertain." Overtones had departed from her voice. "I can merely say that the probability of disaster is high in comparison to the value for travel through normal regions of the galaxy."

"Oh, for chaos' sake!" Laure's laugh was uneasy. "That figure is almost too small to measure. We knew before we entered this nebula that we'd be taking a risk. Now what about coherent radiation from natural sources?"

"My judgment is that the risk is out of proportion to the gain," *Jaccavrie* said. "At best, this is a place for scientific study. You've other work to do. Your basic—and dangerous—fantasy is that you can satisfy the emotional cravings of a few semibarbarians."

Anger sprang up in Laure. He gave it cold shape: "My order was that you report on coherent radiation."

Never before had he pulled the rank of his humanness on her.

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She said like dead metal: "I have detected some in the visible and short infrared, where certain types of star excite pseudo-quasar processes in the surrounding gas. It is dissipated as fast as any other light."

"The radio bands are clear?"

"Yes, of that type of wave, although—"

"Enough. We'll proceed as before, toward the center of the cluster. Cut this view and connect me with *Makt.*"

The hazy suns vanished. Laure was alone in a metal compartment. He took a seat and glowered at the outercom screen before him. What had gotten into *Jaccavrie,* anyway? She'd been making her disapproval of this quest more and more obvious over the last few days. She wanted him to turn around, report to HQ, and leave the Kirkasanters there for whatever they might be able to make of themselves in a lifetime's exile. Well . . . her judgments were always conditioned by the fact that she was a Ranger vessel, built for Ranger work. But couldn't she see that his duty, as well as his desire, was to help Graydal's people?

The screen flickered. The two ships were so differently designed that it was hard for them to stay in phase for any considerable time, and thus hard to receive the modulation imposed on space-pulses. After a while the image steadied to show a face. "I'll switch you to Captain Demring," the communications officer said at once. In his folk, such lack of ceremony was as revealing of strain as haggardness and dark-rimmed eyes.

The image wavered again and became the Old Man's. He was in his cabin, which had direct audio-visual connections, and the background struck Laure anew with outlandishness. What history had brought forth the artistic conventions of that bright-colored, angular-figured tapestry? What song was being sung on the player, in what language, and on what scale? What was the symbolism behind that silver mask on the door?

Worn but indomitable, Demring looked forth and said, "Peace between us. What occasions this call?"

"You should know what I've learned," Laure said. "Uh, can we make this a three-way with your navigator?"

"Why?" The question was machine steady.

"Well, that is, her duties—"

"She is to help carry out decisions," Demring said. "She does not make them. At maximum, she can offer advice in discussion." He waited before adding, with a thrust: "And you have been having a great deal of discussion already with my daughter, Ranger Laure."

"No . . . I mean, yes, but—" The younger man rallied. He did have psych training to call upon, although its use had not yet become reflexive in him. "Captain," he said,

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"Graydal has been helping me understand your ethos. Our two cultures have to see what each other's basics are if they're to cooperate, and that process begins right here, among these ships. Graydal can make things clearer to me, and I believe grasps my intent better, than anyone else of your crew."

"Why is that?" Demring demanded.

Laure suppressed pique at his arrogance—he was her father—and attempted a smile. "Well, sir, we've gotten acquainted to a degree, she and I. We can drop formality and just be friends."

"That is not necessarily desirable," Demring said.

Laure recollected that, throughout the human species, sexual customs are among the most variable. And the most emotionally charged. He put himself inside Demring's prejudices and said with what he hoped was the right slight note of indignation: "I assure you nothing improper has occurred."

"No, no." The Kirkasanter made a brusque, chopping gesture. "I trust her. And you, I am sure. Yet I must warn that close ties, between members of radically different societies, can prove disastrous to everyone involved."

Laure might have sympathized as he thought, *He's afraid to let down his mask—is that why their art uses the motif so much?—but underneath, he is a father worrying about his little girl.* He felt too harassed. First his computer, now this! He said coolly, "I don't believe our cultures are that alien. They're both rational-technological, which is a tremendous similarity to begin with. But haven't we got off the subject? I wanted you to hear the findings this ship has made."

Demring relaxed. The unhuman universe he could cope with. "Proceed at will, Ranger."

When he had heard Laure out, though, he scowled, tugged his beard, and said without trying to hide distress: "Thus we have no chance of finding Kirkasant by ourselves."

"Evidently not," Laure said. "I'd hoped that one of my modern locator systems would work in this cluster. If so, we could have zigzagged rapidly between the stars, mapping them, and had a fair likelihood of finding the group you know within months. But as matters stand, we can't establish an accurate enough grid, and we have nothing to tie any such grid to. Once a given star disappears in the fog, we can't find it again. Not even by straight-line backtracking, because we don't have the navigational feedback to keep on a truly straight line."

"Lost." Demring stared down at his hands, clenched on the desk before him. When he looked up again, the bronze face was rigid with pain. "I was afraid of this," he said. "It is why I was reluctant to come back at all. I feared the effect of

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disappointment on my crew. By now you must know one major respect in which we differ from you. To us, home, kinfolk, ancestral graves are not mere pleasures. They are an important part of our identities. We were prepared to explore and colonize, but not to be totally cut off." He straightened in his seat and turned the confession into a strategic datum by finishing dry-voiced: "Therefore, the sooner we leave this degree of familiarity behind us and accept with physical renunciation the truth of what has happened to us—the sooner we get out of this cluster—the better for us."

"No," Laure said. "I've given a lot of thought to your situation. There *are* ways to navigate here."

Demring did not show surprise. He, too, must have dwelt on contingencies and possibilities. Laure sketched them nevertheless:

"Starting from outside the cluster, we can establish a grid of artificial beacons. I'd guess fifty thousand, in orbit around selected stars, would do. If each has its distinctive identifying signal, a spaceship can locate herself and lay a course. I can imagine several ways to make them. You want them to emit something that isn't swamped by natural noise. Hyperdrive drones, shuttling automatically back and forth, would be detectable in a light-year's radius. Coherent radio broadcasters on the right bands should be detectable at the same distance or better. Since the stars hereabouts are only light-weeks or light-months apart, an electromagnetic network wouldn't take long to complete its link-ups. No doubt a real engineer, turned loose on the problem, would find better answers than these."

"I know," Demring said. "We on *Makt* have discussed the matter and reached similar conclusions. The basic obstacle is the work involved, first in producing that number of beacons, then—more significantly—in planting them. Many man-years, much shipping, must go to that task, if it is to be accomplished in a reasonable time."

"Yes."

"I like to think," said Demring, "that the clans of Hobrok would not haggle over who was to pay the cost. But I have talked with men on Serieve. I have taken heed of what Graydal does and does not relay of her conversations with you. Yours is a mercantile civilization."

"Not exactly," Laure said. "I've tried to explain—"

"Don't bother. We shall have the rest of our lives to learn about your Commonalty. Shall we turn about, now, and end this expedition?"

Laure winced at the scorn but shook his head. "No, best we continue. We can make extraordinary findings here. Things that'll attract scientists. And with a lot of ships buzzing around—"

Demring's smile had no humor. "Spare me, Ranger. There will never be that many scientists come a-

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visiting. And they will never plant beacons throughout the cluster. Why should they? The chance of one of their vessels stumbling on Kirkasant is negligible. They will be after unusual stars and planets, information on magnetic fields and plasmas and whatever else is readily studied. Not even the anthropologists will have any strong impetus to search out our world. They have many others to work on, equally strange to them, far more accessible."

"I have my own obligations," Laure said. "It was a long trip here. Having made it, I should recoup some of the cost to my organization by gathering as much data as I can before turning home."

"No matter the cost to my people?" Demring said slowly. "That they see their own sky around them, but nonetheless are exiles—for weeks longer?"

Laure lost his patience. "Withdraw if you like, captain," he snapped. "I've no authority to stop you. But I'm going on. To the middle of the cluster, in fact."

Demring retorted in a cold flare: "Do you hope to find something that will make you personally rich, or only personally famous?" He reined himself in at once. "This is no place for impulsive acts. Your vessel is undoubtedly superior to mine. I am not certain, either, that *Makt*'s navigational equipment is equal to finding that advanced base where we must refuel her. If you continue, I am bound in simple prudence to accompany you, unless the risks you take become gross. But I urge that we confer again."

"Any time, captain." Laure cut his circuit.

He sat then, for a while, fuming. The culture barrier couldn't be that high. Could it? Surely the Kirkasanters were neither so stupid nor so perverse as not to see what he was trying to do for them. Or were they? Or was it his fault? He'd concentrated more on learning about them than on teaching them about him. Still, Graydal, at least, should know him by now.

The ship sensed an incoming call and turned Laure's screen back on. And there she was. Gladness lifted in him until he saw her expression.

She said without greeting, winter in the golden gaze: "We officers have just been given a playback of your conversation with my father. What is your" (outphasing occurred, making the image into turbulence, filling the voice with staticlike ugliness, but he thought he recognized) "intention?" The screen blanked.

"Maintain contact," Laure told *Jaccavrie*.

"Not easy, in these gravitic fields," the ship said.

Laure jumped to his feet, cracked fist in palm, and shouted, "Is everything trying to brew trouble for me? Bring her back or so help me, I'll scrap you!"

He got a picture again, though it

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was blurred and wavery and the voice was streaked with buzzes and whines, as if he called to Graydal across light-years of swallowing starfog. She said—was it a little more kindly?—"We're puzzled. I was deputed to inquire further, since I am most . . . familiar . . . with you. If our two craft can't find Kirkasant by themselves, why are we going on?"

Laure understood her so well, after the watches when they talked, dined, drank, played music, laughed together, that he saw the misery behind her armor. For her people—for herself—this journey among mists was crueler than it would have been for him had he originated here. He belonged to a civilization of travelers; to him, no one planet could be the land of lost content. But in them would always stand a certain ridge purple against sunset, marsh at dawn, ice cloud walking over wind-gnawed desert crags, ancient castle, wingbeat in heaven . . . and always, always, the dear bright nights that no other place in man's universe knew.

They were a warrior folk. They would not settle down to be pitied; they would forge something powerful for themselves in their exile. But he was not helping them forget their uprootedness.

Thus he almost gave her his true reason. He halted in time and, instead, explained in more detail what he had told Captain Demring. His ship represented a considerable investment, to be amortized over her service life. Likewise, with his training, did he. The time he had spent coming hither was, therefore, equivalent to a large sum of money. And to date, he had nothing to show for that expense except confirmation of a fairly obvious guess about the nature of Kirkasant's surroundings.

He had broad discretion—while he was in service. But he could be discharged. He would be, if his career, taken as a whole, didn't seem to be returning a profit. In this particular case, the profit would consist of detailed information about a unique environment. You could prorate that in such terms as: scientific knowledge, with its potentialities for technological progress; spacefaring experience; public relations—

Graydal regarded him in a kind of horror. "You cannot mean . . . we go on . . . merely to further your private ends," she whispered. Interference gibed at them both.

"No!" Laure protested. "Look, only look, I want to help you. But you, too, have to justify yourselves economically. You're the reason I came so far in the first place. If you're to work with the Commonalty, and it's to help you make a fresh start, you have to show that that's worth the Commonalty's while. Here's where we start proving it. By going on. Eventually, by bringing them a bookful of knowledge they didn't have before."

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Her gaze upon him calmed but remained aloof. "Do you think that is right?"

"It's the way things are, anyhow," he said. "Sometimes I wonder if my attempts to explain my people to you haven't glided right off your brain."

"You have made it clear that they think of nothing but their own good," she said thinly.

"If so, I've failed to make anything clear." Laure slumped in his chair web. Some days hit a man with one club after the next. He forced himself to sit erect again and say:

"We have a different ideal from you. Or no, that's not correct. We have the same set of ideals. The emphases are different. You believe the individual ought to be free and ought to help his fellow man. We do, too. But you make the service basic, you give it priority. We have the opposite way. You give a man, or a woman, duties to the clan and the country from birth. But you protect his individuality by frowning on slavishness and on anyone who doesn't keep a strictly private side to his life. We give a person freedom, within a loose framework of common-sense prohibitions. And then we protect his social aspect by frowning on greed, selfishness, callousness."

"I know," she said. "You have—"

"But maybe you haven't thought how we *must* do it that way," he pleaded. "Civilization's gotten too big out there for anything but freedom to work. The Commonalty isn't a government. How would you govern ten million planets? It's a private, voluntary, mutual-benefit society, open to anyone anywhere who meets the modest standards. It maintains certain services for its members, like my own space rescue work. The services are widespread and efficient enough that local planetary governments also like to hire them. But I don't speak for my civilization. Nobody does. You've made a friend of me. But how do you make friends with ten million times a billion individuals?"

"You've told me before," she said.

And it didn't register. Not really. Too new an idea for you, I suppose, Laure thought. He ignored her remark and went on:

"In the same way, we can't have a planned interstellar economy. Planning breaks down under the sheer mass of detail when it's attempted for a single continent. History is full of cases. So we rely on the market, which operates as automatically as gravitation. Also as efficiently, as impersonally, and sometimes as ruthlessly—but we didn't make this universe. We only live in it."

He reached out his hands, as if to touch her through the distance and the distortion. "Can't you see? I'm not able to help your plight. Nobody is. No individual quadrillionaire, no foundation, no government, no consortium could pay the cost of finding your home for you.

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It's not a matter of lacking charity. It's a matter of lacking resources for that magnitude of effort. The resources are divided among too many people, each of whom has his own obligations to meet first.

"Certainly, if each would contribute a pittance, you should buy your fleet. But the tax mechanism for collecting that pittance doesn't exist and can't be made to exist. As for free-will donations—how do we get your message across to an entire civilization, that big, that diverse, that busy with its own affairs?—which include cases of need far more urgent than yours.

"Graydal, we're not greedy where I come from. We're helpless."

She studied him at length. He wondered, but could not see through the ripplings, what emotions passed across her face. Finally she spoke, not altogether ungently, though helmeted again in the reserve of her kindred, and he could not hear anything of it through the buzzings except: ". . . proceed, since we must. For a while, anyhow. Good watch, Ranger."

The screen blanked. This time he couldn't make the ship repair the connection for him.

At the heart of the great cluster, where the nebula was so thick as to be a nearly featureless glow, pearl-hued and shot with rainbows, the stars were themselves so close that thousands could be seen. The spaceships crept forward like frigates on unknown seas of ancient Earth. For here was more than fog; here were shoals, reefs, and riptides. Energies travailed in the plasma. Drifts of dust, loose planets, burnt-out suns lay in menace behind the denser clouds. Twice *Makt* would have met catastrophe, had not *Jaccavrie* sensed the danger with keener instruments and cried a warning to sheer off.

After Demring's subsequent urgings had failed, Graydal came aboard in person to beg Laure that he turn homeward. That she should surrender her pride to such an extent bespoke how worn down she and her folk were. "What are we gaining worth the risk?" she asked shakenly.

"We're proving that this is a treasure house of absolutely unique phenomena," he answered. He was also hollowed, partly from the long travel and the now constant tension, partly from the half estrangement between him and her. He tried to put enthusiasm in his voice. "Once we've reported, expeditions are certain to be organized. I'll bet the foundations of two or three whole new sciences will get laid here."

"I know. Everything astronomical, in abundance, close together and interacting." Her shoulders drooped. "But our task isn't research. We can go back now, we could have gone back already, and carried enough details with us. Why do we not?"

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"I want to investigate several planets yet, on the ground, in different systems," he told her. "Then we'll call a halt."

"What do they matter to you?"

"Well, local stellar spectra are freakish. I want to know if the element abundances in solid bodies correspond."

She stared at him. "I do not understand you," she said. "I thought I did, but I was wrong. You have no compassion. You led us, you lured us so far in that we can't escape without your ship for a guide. You don't care how tired and tormented we are. You can't, or won't, understand why we are anxious to live."

"I am myself," he tried to grin. "I enjoy the process."

The dark head shook. "I said you won't understand. We do not fear death for ourselves. But most of us have not yet had children. We do fear death for our bloodlines. We *need* to find a home, forgetting Kirkasant, and begin our families. You, though, you keep us on this barren search—why? For your own glory?"

He should have explained then. But the strain and weariness in him snapped: "You accepted my leadership. That makes me responsible for you, and I can't be responsible if I don't have command. You can endure another couple of weeks. That's all it'll take."

And she should have answered that she knew his motives were good and wished simply to hear his reasons. But being the descendant of hunters and soldiers, she clicked heels together and flung back at him: "Very well, Ranger. I shall convey your word to my captain."

She left, and did not again board *Jaccavrie*.

Later, after a sleepless "night," Laure said, "Put me through to *Makt*'s navigator."

"I wouldn't advise that," said the woman-voice of his ship.

"Why not?"

"I presume you want to make amends. Do you know how she—or her father, or her young male shipmates that must be attracted to her—how they will react? They are alien to you, and under intense strain."

"They're human!"

Engines pulsed. Ventilators whispered. "Well?" said Laure.

"I'm not designed to compute about emotions, except on an elementary level," *Jaccavrie* said. "But please recollect the diversity of mankind. On Reith, for example, ordinary peaceful men can fall into literally murderous rages. It happens so often that violence under those circumstances is not a crime in their law. A Talatto will be patient and cheerful in adversity, up to a certain point: after which he quits striving, contemplates his God, and waits to die. You can think of other cultures. And they are within the ambience of the

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Commonalty. How foreign might not the Kirkasanters be?"

"Um-m-m—"

"I suggest you obtrude your presence on them as little as possible. That makes for the smallest probability of provoking some unforeseeable outburst. Once our task is completed, once we are bound home, the stress will be removed and you can safely behave toward them as you like."

"Well . . . you may be right." Laure stared dull-eyed at a bulkhead. "I don't know. I just don't know."

Before long, he was too busy to fret much. *Jaccavrie* went at his direction, finding planetary systems that belonged to various stellar types. In each, he landed on an airless body, took analytical readings and mineral samples, and gave the larger worlds a cursory inspection from a distance.

He did not find life. Not anywhere. He had expected that. In fact, he was confirming his whole guess about the inmost part of the cluster.

Here gravitation had concentrated dust and gas till the rate of star production became unbelievable. Each time the cluster passed through the clouds around galactic center and took on a new load of material, there must have been a spate of supernovae, several per century for a million years or more. He could not visualize what fury had raged; he scarcely dared put his estimate in numbers. Probably radiation had sterilized every abode of life for fifty light-years around. (Kirkasant must, therefore, lie further out—which fitted in with what he had been told, that the interstellar medium was much denser in this core region than in the neighborhood of the vanished world.)

Nuclei had been cooked in stellar interiors, not the two, three, four star-generations which have preceded the majority of the normal galaxy—here, a typical atom might well have gone through a dozen successive supernova explosions. Transformation built on transformation. Hydrogen and helium remained the commonest elements, but only because of overwhelming initial abundance. Otherwise the lighter substances had mostly become rare. Planets were like nothing ever known before. Giant ones did not have thick shells of frozen water, nor did smaller ones have extensive silicate crusts. Carbon, oxygen, nitrogen, sodium, aluminum, calcium were all but lost among . . . iron, gold, mercury, tungsten, bismuth, uranium and transuranics — On some little spheres Laure dared not land. They radiated too fiercely. A heavily armored robot might someday set foot on them, but never a living organism.

The crew of *Makt* didn't offer to help him. Irrational in his hurt, he didn't ask them. *Jaccavrie* could carry on any essential communica-

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tion with their captain and navigator. He toiled until he dropped, woke, fueled his body, and went back to work. Between stars, he made detailed analyses of his samples. That was tricky enough to keep his mind off Graydal. Minerals like these could have formed nowhere but in this witchy realm.

Finally the ships took orbit around a planet that had atmosphere. "Do you indeed wish to make entry there?" the computer asked. "I would not recommend it."

"You never recommend anything I want to do," Laure grunted. "I know air adds an extra factor to reckon with. But I want to get some idea of element distribution at the surface of objects like that." He rubbed bloodshot eyes. "It'll be the last. Then we go home."

"As you wish." Did the artificial voice actually sigh? "But after this long a time in space, you'll have to batten things down for an aerodynamic landing."

"No, I won't. I'm taking the sled as usual. You'll stay put."

"You are being reckless. This isn't an airless globe where I can orbit right above the mountaintops and see everything that might happen to you. Why, if I haven't misgauged, the ionosphere is so charged that the sled radio can't reach me."

"Nothing's likely to go wrong," Laure said. "But should it, you can't be spared. The Kirkasanters need you to conduct them safely out."

"I—"

"You heard your orders." Laure proceeded to discuss certain basic precautions. Not that he felt they were necessary. His objective looked peaceful—dry, sterile, a stone spinning around a star.

Nevertheless, when he departed the main hatch and gunned his gravity sled to kill velocity, the view caught at his breath.

Around him reached the shining fog. Stars and stars were caught in it, illuminating caverns and tendrils, aureoled with many-colored fluorescences. Even as he looked, one such point, steely blue, multiplied its brilliance until the intensity hurt his eyes. Another nova. Every stage of stellar evolution was so richly represented that it was as if time itself had been compressed—cosmos, what an astrophysical laboratory!

(For unmanned instruments, as a general rule. Human flesh couldn't stand many months in a stretch of the cosmic radiation that sleeted through these spaces, the synchrotron and betatron and Cerenkov quanta that boiled from particles hurled in the gas across the intertwining magnetism of atoms and suns. Laure kept glancing at the cumulative exposure meter on his left wrist.)

The solar disk was large and lurid orange. Despite thermostating in the sled, Laure felt its heat strike at him through the bubble and his own armor. A stepdown viewer re-

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vealed immense prominences licking flame-tongues across the sky, and a heartstoppingly beautiful corona. A Type K shouldn't be that spectacular, but there were no normal stars in sight—not with this element distribution and infall.

Once the planet he was approaching had been further out. But friction with the nebula, over gigayears, was causing it to spiral inward. Surface temperature wasn't yet excessive, about 50° C., because the atmosphere was thin, mainly noble gases. The entire world hadn't sufficient water to fill a decent lake. It rolled before him as a gloom little relieved by the reddish blots of gigantic dust storms. Refracted light made its air a fiery ring.

His sled struck that atmosphere, and for a while he was busy amidst thunder and shudder, helping the autopilot bring the small craft down. In the end, he hovered above a jumbled plain. Mountains bulked bare on the near horizon. The rock was black and brown and darkly gleaming. The sun stood high in a deep purple heaven. He checked with an induction probe, confirmed that the ground was solid—in fact, incredibly hard—and landed.

When he stepped out, weight caught at him. The planet had less diameter than the least of those on which men live, but was so dense that gravity stood at 1.22 standard G. An unexpectedly strong wind shoved at him. Though thin, the air was moving fast. He heard it wail through his helmet. From afar came a rumble, and a quiver entered his boots and bones. Landslide? Earthquake? Unseen volcano? He didn't know what was or was not possible here. Nor, he suspected, did the most expert planetologist. Worlds like this had not hitherto been trodden.

Radiation from the ground was higher than he liked. Better do his job quickly. He lugged forth apparatus. A power drill for samples—he set it up and let it work while he assembled a pyroanalyzer and fed it a rock picked off the chaotic terrain. Crumbled between alloy jaws, flash heated to vapor, the mineral gave up its fundamental composition to the optical and mass spectrographs. Laure studied the printout and nodded in satisfaction. The presence of atmosphere hadn't changed matters. This place was loaded with heavy metals and radioactives. He'd need a picture of molecular and crystalline structures before being certain that they were as easily extractible as he'd found them to be on the other planets; but he had no reason to doubt it.

Well, he thought, aware of hunger and aching feet, *let's relax a while in the cab, catch a meal and a nap, then go check a few other spots, just to make sure they're equally promising; and then—*

The sky exploded.

He was on his belly, faceplate buried in arms against that flash,

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before his conscious mind knew what had happened. Rangers learn about nuclear weapons. When, after a minute, no shock wave had hit him, no sound other than a rising wind, he dared sit up and look.

The sky had turned white. The sun was no longer like an orange lantern but molten brass. He couldn't squint anywhere near it. Radiance crowded upon him, heat mounted even as he climbed erect. *Nova,* he thought in his rocking reality, and caught Graydal to him for the moment he was to become a wisp of gas.

But he remained alive, alone, on a plain that now shimmered with light and mirage. The wind screamed louder still. He felt how it pushed him, and how the mass of the planet pulled, and how his mouth was dry and his muscles tautened for a leap. The brilliance pained his eyes, but was not unendurable behind a self-adapting faceplate and did not seem to be growing greater. The infrared brought forth sweat on his skin, but he was not being baked.

Steadiness came. Something almighty strange was happening. It hadn't killed him yet, though. As a check, with no hope of making contact, he tuned his radio. Static brawled in his earplugs.

His heart thudded. He couldn't tell whether he was afraid or exhilarated. He was, after all, quite a young man. But the coolness of his training came upon him. He didn't stop feeling. Wildness churned beneath self-control. But he did methodically begin to collect his equipment, and to reason while he acted.

Not a nova burst. Main sequence stars don't go nova. They don't vary in seconds, either . . . but then, every star around here is abnormal. Perhaps, if I'd checked the spectrum of this one, I'd have seen indications that it was about to move into another phase of a jagged output cycle. Or perhaps I wouldn't have known what the indications meant. Who's studied astrophysics in circumstances like these?

What had occurred might be akin to the Wolf-Rayet phenomenon, he thought. The stars around him did not evolve along ordinary lines. They had strange compositions to start with. And then matter kept falling into them, changing that composition, increasing their masses. That must produce instability. Each spectrum he had taken, in this heart of the cluster, showed enormous turbulence in the surface layers. So did the spots, flares, prominences, coronas he had seen. Well, the turbulence evidently went deeper than the photospheres. Actual stellar cores and their nuclear furnaces might be affected. Probably every local sun was a violent variable.

Even in the less dense regions, stars must have peculiar careers. The sun of Kirkasant had apparently been stable for five thousand years—or several million, more

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likely, since the planet had well developed native life. But who could swear it would stay thus? Destruction! The place had to be found, had to, so that the people could be evacuated if need arose. You can't let little children fry—

Laure checked his radiation meter. The needle climbed ominously fast up the dial. Yonder sun was spitting X rays, in appreciable quantity, and the planet had no ozone layer to block them. He'd be dead if he didn't get to shelter—for choice, his ship and her force-screens—before the ions arrived. Despite its density, the globe had no magnetic field to speak of, either, to ward them off. Probably the core was made of stuff like osmium and uranium. Such a weird blend might well be solid rather than molten. *I don't know about that. I do know I'd better get my tail out of here.*

The wind yelled. It began driving ferrous dust against him, borne from somewhere else. He saw the particles scud in darkling whirls and heard them click on his helmet. Doggedly, he finished loading his gear. When at last he entered the sled cab and shut the air lock, his vehicle was trembling under the blast and the sun was reddened and dimmed by haze.

He started the motor and lifted. No sense in resisting the wind. He was quite happy to be blown toward the night side. Meanwhile he'd gain altitude, then get above the storm, collect orbital velocity and—

He never knew what happened. The sled was supposedly able to ride out more vicious blows than any this world could produce. But who could foretell what this world was capable of? The atmosphere, being thin, developed high velocities. Perhaps the sudden increased irradiation had triggered paroxysm in a cyclone cell. Perhaps the dust, which was conductive, transferred energy into such a vortex at a greater rate than one might believe. Laure wasn't concerned about meteorological theory.

He was concerned with staying alive, when an instant blindness clamped down upon him, and a shriek that nigh tore the top off his skull, and he was whirled like a leaf and cast against a mountainside.

The event was too fast for awareness, for anything but reaction. His autopilot and he must, somehow, have got some control. The crash ruined the sled, ripped open its belly, scattered its cargo, but did not crumple the cab section. Shock harness kept the man from serious injury. He was momentarily unconscious, but came back with no worse than an aching body and blood in his mouth.

Wind hooted. Dust went hissing and scouring. The sun was a dim red disk, though from time to time a beam of pure fire struck through the storm and blazed off metallic cliffsides.

Laure fumbled with his harness and stumbled out. Half seen, the

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slope on which he stood caught at his feet with cragginess. He had to take cover. The beta particles would arrive at any moment, the protons within hours, and they bore his death.

He was dismayed to learn the stowed equipment was gone. He dared not search for it. Instead, he made his clumsy way into the murk.

He found no cave—not in this waterless land—but by peering and calculating (odd how calm you can grow when your life depends on your brain) he discovered in what direction his chances were best, and was rewarded. A one-time landslide had piled great slabs of rock on each other. Among them was a passage into which he could crawl.

Then nothing to do but lie in that narrow space and wait.

Light seeped around a bend, with the noise of the storm. He could judge thereby how matters went outside. Periodically he crept to the entrance of his dolmen and monitored the radiation level. Before long it had reached such a count that—space armor, expert therapy, and all—an hour's exposure would kill him.

He must wait.

Jaccavrie knew the approximate area where he intended to set down. She'd come looking as soon as possible. Flitting low, using her detectors, she'd find the wrecked sled. More than that she could not do unaided. But he could emerge and call her. Whether or not they actually saw each other, in this mountainscape, he could emit a radio signal for her to home on. She'd hover, snatch him with a force-beam, and reel him in.

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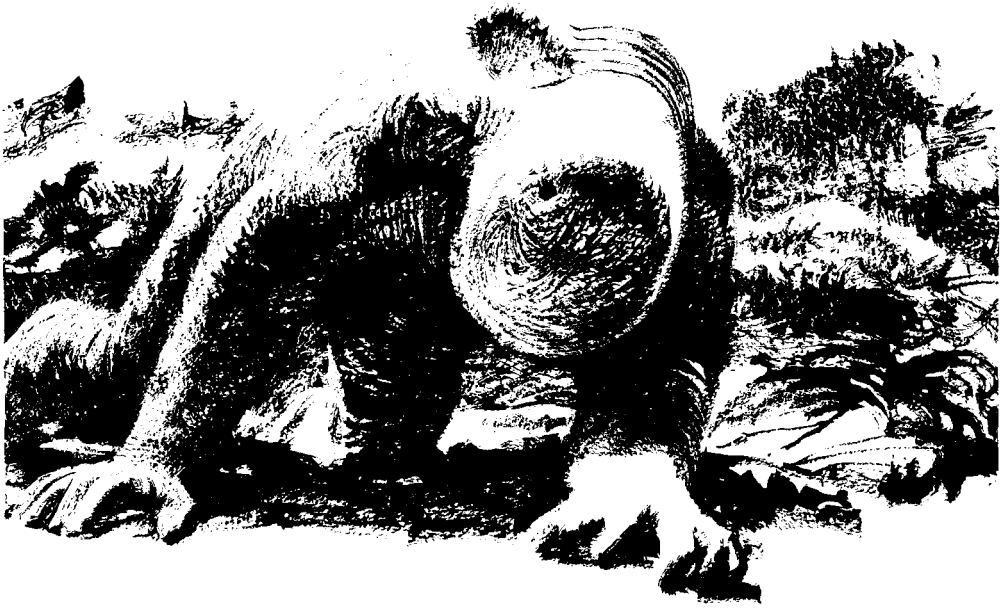

But . . . this depended on calm weather. *Jaccavrie* could overmaster any wind. But the dust would blind both her and him. And deafen and mute them; it was conductive, radio could not get through. Laure proved that to his own satisfaction by experimenting with the miniradar built into his armor.

So everything seemed to depend on which came first, the end of the gale, or the end of Laure's powerpack. His air renewer drew on it. About thirty hours' worth of charge remained before he choked on his own breath. If only he'd been able to grab a spare accumulator or two, or better still, a hand-cranked recharger! They might have rolled no more than ten meters off. But he had decided not to search the area. And by now, he couldn't go back. Not through the radiation.

He sighed, drank a bit from his water nipple, ate a bit through his chowlock, wished for a glass of beer and a comfortable bed, and went to sleep.

When he awoke, the wind had dropped from a full to a half gale; but the dust drift was so heavy as to conceal the glorious starfog night that had fallen. It screened off some of the radiation, too, though not enough to do him any good. He puzzled over why the body of the planet wasn't helping more. Finally he decided that ions, hitting the upper air along the terminator, produced secondaries and cascades which descended everywhere.

The dayside bombardment must really have got fierce!

Twenty hours left. He opened the life-support box he had taken off

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his shoulder rack, pulled out the sanitary unit, and attached it. Men don't die romantically, like characters on a stage. Their bodies are too stubborn.

So are their minds. He should have been putting his thoughts in order, but he kept being disturbed by recollections of his parents, of Graydal, of a funny little tavern he'd once visited, of a gaucherie he'd rather forget, of some money owing to him, of Graydal—He ate again, and drowsed again, and the wind filled the air outside with dust, and time closed in like a hand.

Ten hours left. No more?

Five. Already?

What a stupid way to end. Fear fluttered at the edge of his perception. He beat it off. The wind yammered. How long can a dust storm continue, anyhow? Where'd it come from? Daylight again, outside his refuge, colored like blood and brass. The charged particles and X rays were so thick that some diffused in to him. He shifted cramped muscles, and drank the stench of his unwashed skin, and regretted everything he had wanted and failed to do.

A shadow, cast on the cornering rock. A rustle and slither, conducted to his ears. A form, bulky and awkward as his own, crawling around the tunnel bend. Numb, shattered, he switched on his radio. The air was fairly clear in here and he heard her voice through the static: ". . . you are, you are alive! Oh, Valfar's Wings upbear us, you live!"

He held her while she sobbed, and he wept, too. "You shouldn't have," he stammered. "I never meant for *you* to risk yourself—"

"We dared not wait," she said when they were calmer. "We saw, from space, that the storm was enormous. It would go on in this area for days. And we didn't know how long you had to live. We only knew you were in trouble, or you'd have been back with us. We came down. I almost had to fight my father, but I won and came. The hazard wasn't so great for me. Really, no, believe me. She protected me till we found your sled. Then I did have to go out afoot, with a metal detector, to find you. Because you were obviously sheltered somewhere, and so you could only be detected at closer range than she can come. But the danger wasn't that great, Daven. I can stand much more radiation than you. I'm still well inside my tolerance, won't even need any drugs. Now I'll shoot off this flare, and she'll see, and come so close that we can make a dash—You are all right, aren't you? You swear it?"

"Oh, yes," he said slowly. "I'm fine. Better off than ever in my life." Absurdly, he had to have the answer, however footling all questions were against the fact that she had come after him and was here and they were both alive. "We? Who's your companion?"

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She laughed and clinked her faceplate against his. *"Jaccavrie,* of course. Who else? You didn't think your womenfolk were about to leave you alone, did you?"

The ships began their trek homeward. They moved without haste. Best to be cautious until they had emerged from the nebula, seen where they were, and aimed themselves at the Dragon's Head.

"My people and I are pleased at your safety," said Demring's image in the outercom screen. He spoke under the obligation to be courteous, and could not refrain from adding: "We also approve your decision not to investigate that planet further."

"For the first, thanks," Laure answered. "As for the second—" He shrugged. "No real need. I was curious about the effects of an atmosphere. But my computer has just run off a probability analysis of the data I already have, which proves that no more are necessary for my purposes."

"May one inquire what your purposes are?"

"I'd like to discuss that first with your navigator. In private."

The green gaze studied Laure before Demring said, unsmiling: "You have the right of command. And by our customs, she having been instrumental in saving your life, a special relationship exists. But again I counsel forethought."

Laure paid no attention to that last sentence. His pulse was beating too gladly. He switched off as soon as possible and ordered the best dinner his ship could provide.

"Are you certain you want to make your announcement through her?" the voice asked him. "And to her in this manner?"

"I am. I think I've earned the pleasure. Now I'm off to make myself presentable for the occasion. Carry on." Laure went whistling down the corridor.

But when Graydal boarded, he took both her hands and they looked long in silence at each other. She had strewn jewels in her tresses, turning them to a starred midnight. Her clothes were civilian, a deep blue that offset coppery skin, amber eyes, and suppleness. And did he catch the least woodsy fragrance of perfume?

"Welcome," was all he could say at last.

"I am so happy," she answered.

They went to the saloon and sat down on the couch together. Daiquiris were ready for them. They touched glasses. "Good voyage," he made the old toast, "and merry landing."

"For me, yes." Her smile faded. "And I hope for the rest. How I hope."

"Don't you think they can get along in the outside worlds?"

"Yes, undoubtedly." The incredible lashes fluttered. "But they will never be as fortunate as . . . as I think I may be."

"You have good prospects, your-

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self?" The blood roared in his temples.

"I am not quite sure," she replied shyly.

He had intended to spin out his surprise at length, but suddenly he couldn't let her stay troubled, not to any degree. He cleared his throat and said, "I have news."

She tilted her head and waited, with that relaxed alertness he liked to see. He wondered how foolish the grin was on his face. Attempting to recover dignity, he embarked on a roundabout introduction.

"You wondered why I insisted on exploring the cluster center, and in such detail. Probably I ought to have explained myself from the beginning. But I was afraid of raising false hopes. I'd no guarantee that things would turn out to be the way I'd guessed. Failure, I thought, would be too horrible for you, if you knew what success could mean. But I was working on your behalf, nothing else.

"You see, because my civilization is founded on individualism, it makes property rights quite basic. In particular, if there aren't any inhabitants or something like that, discoverers can claim ownership within extremely broad limits.

"Well, we . . . you . . . our expedition has met the requirements of discovery, as far as those planets are concerned. We've been there, we've proven what they're like, we've located them as well as might be without beacons—"

He saw how she struggled not to be too sanguine. "That isn't a true location," she said. "I can't imagine how we will ever lead anybody back to precisely those stars."

"Nor can I," he said. "And it doesn't matter. Because, well, we took an adequate sample. We can be sure, now, that practically every star in the cluster heart has planets that are made of heavy elements. So it isn't necessary, for their exploitation, to go to any particular system. In addition, we've learned about hazards and so forth, gotten information that'll be essential to other people. And therefore"—he chuckled—"I guess we can't file a claim on your entire Cloud Universe. But any court will award you . . . us . . . a fair share. Not specific planets, since they can't be found right away. Instead, a share of everything. Your crew will draw royalties on the richest mines in the galaxy. On millions of them."

She responded with thoughtfulness rather than enthusiasm. "Indeed? We did wonder, on *Makt,* if you might not be hoping to find abundant metals. But we decided that couldn't be. For why would anyone come here for them? Can they not be had more easily, closer to home?"

Slightly dashed, he said, "No. Especially when most worlds in this frontier are comparatively metal-poor. They do have some veins of ore, yes. And the colonists can extract anything from the oceans, as

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on Serieve. But there's a natural limit to such a process. In time, carried out on the scale that'd be required when population has grown . . . it'd be releasing so much heat that planetary temperature would be affected."

"That sounds farfetched."

"No. A simple calculation will prove it. According to historical records, Earth herself ran into the problem, and not terribly long after the industrial era began. However, quite aside from remote prospects, people will want to mine these cluster worlds immediately. True, it's a long haul, and operations will have to be totally automated. But the heavy elements that are rare elsewhere, are so abundant here as to more than make up for those extra costs." He smiled. "I'm afraid you can't escape your fate. You're going to be . . . not wealthy. To call you 'wealthy' would be like calling a supernova 'luminous'. You'll command more resources than many whole civilizations have done."

Her look upon him remained grave. "You did this for us? You should not have. What use would riches be to us if we lost you?"

He remembered that he couldn't have expected her to carol about this. In her culture, money was not unwelcome, but neither was it an important goal. So what she had just said meant less than if a girl of the Commonalty had spoken. Nevertheless, joy kindled in him. She sensed that, laid her hand across his, and murmured, "But your thought was noble."

He couldn't restrain himself any longer. He laughed aloud. "Noble?" he cried. "I'd call it clever. Fiendishly clever. Don't you see? I've given you Kirkasant back!"

She gasped.

He jumped up and paced exuberant before her. "You could wait a few years, till your cash reserves grow astronomical, and buy as big a fleet as you want to search the cluster. But it isn't needful. When word gets out, the miners will come swarming. They'll plant beacons. they'll have to. The grid will be functioning within one year, I'll bet. As soon as you can navigate, identify where you are and where you've been, you can't help finding your home—in weeks!"

FOOTNOTE TO VIKING SAGAS *The term "viking" stems from an Old Norse root, "vik," meaning "to yield, to surrender, to relax." To "go viking" was, then, to "go relaxing"—i.e., to take a vacation.*

It now becomes evident that the Vikings were, in fact, perfectly equivalent to modern tourists. They came in swarms, collected souvenirs, chased all the local girls, got into fights, and generally ruined the local way of life.

As the natives became used to these vacationers, they learned to welcome them, cheat them, sell them third-rate souvenirs, and eventually the tourists learned to go elsewhere.

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She joined him, then, casting herself into his arms, laughing and weeping. He had known of emotional depth in her, beneath the schooled reserve. But never before now had he found as much warmth as was hers.

Long, long afterward, air locks linked and she bade him goodnight. "Until tomorrow," she said.

"Many tomorrows, I hope."

"And I hope. I promise."

He watched the way she had gone until the locks closed again and the ships parted company. A little drunkenly, not with alcohol, he returned to the saloon for a nightcap.

"Turn off that color thing," he said. "Give me an outside view."

The ship obeyed. In the screen appeared stars, and the cloud from which stars were being born. "Her sky," Laure said. He flopped onto the couch and admired.

"I might as well start getting used to it," he said. "I expect I'll spend a lot of vacation time, at least, on Kirkasant."

"Daven," said *Jaccavrie.*

She was not in the habit of addressing him thus, and so gently. He started. "Yes?"

"I have been—" Silence hummed for a second. "I have been wondering how to tell you. Any phrasing, any inflection, could strike you as something I computed would produce an effect. I am only a machine."

Though unease prickled him, he leaned forward to touch a bulkhead. It trembled a little with her engine energy. "And I, old girl," he said. "Or else you also are an organism. We're both people."

"Thank you," said the ship, almost too low to be heard.

Laure braced himself. "What did you have to tell me?"

She forgot about keeping her voice humanized. The words clipped forth: "I finished the chromosome analysis some time ago. Thereafter I tried to discourage certain tendencies I noticed in you. But now I have no way to avoid giving you the plain truth. They are not human on that planet."

"What?" he yelled. The glass slipped from his hand and splashed wine red across the deck. "You're crazy! Records, traditions, artifacts, appearance, behavior—"

The ship's voice came striding across his. "Yes, they are human descended. But their ancestors had to make an enormous adaptation. The loss of night vision is merely indicative. The fact that they can, for example, ingest heavy metals like arsenic unharmed, might be interpreted as simple immunity. But you will recall that they find unarsenated food tasteless. Did that never suggest to you that they have developed a metabolic requirement for the element? And you should have drawn a conclusion from their high tolerance for ionizing radiation. It cannot be due to their hav-

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ing stronger proteins, can it? No, it must be because they have evolved a capacity for extremely rapid and error-free repair of chemical damage from that source. This in turn is another measure of how different their enzyme system is from yours.

"Now the enzymes, of course, are governed by the DNA of the cells, which is the molecule of heredity—"

"Stop," Laure said. His speech was as flat as hers. "I see what you're at. You are about to report that your chromosome study proved the matter. My kind of people and hers can't reproduce with each other."

"Correct," *Jaccavrie* said.

Laure shook himself, as if he were cold. He continued to look at the glowing fog. "You can't call them nonhuman on that account."

"A question of semantics. Hardly an important one. Except for the fact that Kirkasanters apparently are under an instinctual compulsion to have children."

"I know," Laure said.

And after a time: "Good thing, really. They're a high-class breed. We could use a lot of them."

"Your own genes are above average," *Jaccavrie* said.

"Maybe. What of it?"

Her voice turned alive again. "I'd like to have grandchildren," she said wistfully.

Laure laughed. "All right," he said. "No doubt one day you will." The laughter was somewhat of a victory. ■

The Analytical Laboratory

April 1967

PLACE	STORY	AUTHOR	POINT SCORE
1.	The Time-Machined Saga (*Part Two*)	*Harry Harrison*	1.89
2.	To Love Another	*James Blish and Norman L. Knight*	2.57
3.	Ambassador to Verdammt	*Colin Kapp*	3.01
4.	To Change Their Ways	*Joseph P. Martino*	3.24
5.	The Enemy Within	*Mack Reynolds*	4.07

May 1967

1.	The Time-Machined Saga (*Conclusion*)	*Harry Harrison*	1.99
2.	Of Terrans Bearing Gifts	*Richard Grey Sipes*	2.08
3.	Experts in the Field	*Christopher Anvil*	2.99
4.	Burden of Proof	*Bob Shaw*	3.81
5.	Dead End	*Mike Hodous*	4.00

THE EDITOR

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Babel II

The next World Crisis may not be very easy to state in clear, unequivocal English. This makes things very hard to describe—

CHRISTOPHER ANVIL

Illustrated by Rudi Palais

The new Assistant Secretary of State doubtfully eased along the row of seats in the big dim room, and settled scowlingly into a chair beside the well-known Kremlinologist.

"Damn it, Bill," growled the Assistant Secretary, "if I'd known this was where you got your inside information—"

"*Sh-h,*" said the Kremlinologist, raising a finger. "We're about to start."

At the front of the room, under a single clear light, Madame Sairo signaled to her assistants.

The room's overhead lights dimmed further. A blond boy dressed all in white rolled out on heavy casters a thing that at first glance looked like a big globe of the world set in a large holder, but on closer examination turned out to be a crystal ball about two feet thick.

Madame Sairo adjusted the big crystal, and took her seat.

The room fell silent. The Kremlinologists, the Far East experts, and the Government economists leaned forward attentively.

The new Assistant Secretary of State eyed the crystal ball sourly.

Madame Sairo gazed intently into the crystal, her mind focused on the question of the evening. For some time, however, she got nowhere, and when the mists finally did begin to shred away, the scene that formed did not seem to be right. Frowning, she watched the unfamiliar man at the desk.

Elias Polk, for the fourth time trying to extract the sense of this latest report on the Esmer Drive, was stuck again on the section reading:

". . . difficulty remains in the suffluxion of the tantron stream, and resultant violent node-regression. Yet any other approach obviously requires consideration of Hasebrouck's theory of complex particle-interaction . . ."

Polk's train of thought each time went off the track at that word "obviously." *Why* did any other ap-

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proach obviously require consideration of Hasebrouck's theory?

Polk flipped on through the report.

There followed five pages of Hasebrouck's del, ro-del, and pi-del equations, and then it all ended up with the words:

". . . therefore, we unequivocally recommend construction of the 175-TEV tangential accelerator."

That followed from consideration of Hasebrouck's equations, and Hasebrouck's equations came in because "any other approach obviously requires consideration of Hasebrouck's theory . . ."

Why was it obvious?

Polk looked up exasperatedly at the reversed letters on the glass of the door, from long familiarity reading them as easily as someone in the hall outside:

PROJECT LONG-REACH

J. Elias Polk
Director

Polk squinted at the report, tossed it down, picked up some papers, and thumbed through them. He settled back, scowling.

The estimated cost of that accelerator was seventy-two billions, over nine years. But with that for the original estimate, the true cost would probably run well above a hundred billion, and it would take twelve years.

Even then, no one could be sure that would give them enough information to eventually straighten out the difficulty.

Polk glanced back at the report.

". . . *obviously* any other approach requires consideration of Hasebrouck's . . ."

Why 'obviously'?

Frowning, Polk reached for the phone.

As the scene faded, Madame Sairo sat back blankly. Just what did *that* have to do with anything? What her clients wanted to know—

But there, a new scene was forming. She leaned forward hopefully.

The door opened, and Marcus Flint stepped out into the hall, the sheets of calculations and the charts with their pretty colored lines clutched in his hand. He strode down the hall, and threw open a second door without knocking.

"Are you out of your head, Peters? What do you think I'm running here, a market report or an obituary column?"

Peters adjusted his thick lenses and set his jaw. "Our computer analysis showed the projected OJDA taking a nose dive through the TL, with our PF matrix-model running out of steam before the year is out. We're in for a depression that could jar your teeth, MF."

"Nuts. With this big spending for space projects—"

"That spending for space projects is increasing on our Chart III,

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there, to the point where it overshoots the stimulus role, and turns into a drain, pure and simple. Especially when you consider that Chart IV shows external and internal unidirectional cycle flow—"

"Will you, for God's sake—" Flint caught himself. "Look, I'll grant your expertise. Spare me this jargon, will you? What is external and internal unidirectional cycle flow?"

"Value tokens in unidirectional circulation, external or internal to the national economy, unaccompanied by a reverse flow of actual-value services or goods, either essential, marginal, or redundant."

"*Unearned money?* Giveaway programs?"

Peters blinked. "Well— Yes, I suppose you *could* put it that way."

"All right, what about unearned money?"

Peters started to speak, hesitated, and shook his head. "I can't use that term 'unearned money.' It has extraneous moral connotations. The moral connotations block consideration of the purely economic factors per se."

"All right," snarled Flint. "Then what about this unidirectional cycle flow?"

"We have a serious maladjustment of the reverse flow of actual-value units. Deferred payment of value tokens for actual-value units is not presently serious in itself. However, this continuing increase in the flow of value tokens with neither past, present, nor future correlated return flow of actual-value units creates an imbalance in the circuit flow, and that *is* serious."

Flint grappled with the statement, and finally quoted, " 'This grasping after unearned money will in time wreck the country.' I think Abraham Lincoln said that."

"He *did?*" Peters blinked, then squirmed uneasily, "But that term 'unearned money' implies a—"

"All right," snarled Flint, " 'unidirectional cycle flow.' Have it your own way. The point is, this projection of yours is so drastic no one will *believe* it. Its value, therefore, is nil. Moreover, jargon is great for mystifying people and impressing them with your expertise. But you've already accomplished *that.* It's a good idea to occasionally say something someone can understand, so he'll keep listening in hopes it will happen again. You've got this special lingo—"

Peters said stiffly, "Precise terminology is necessary, in order to express the special economic forces and relationships operative in the economy."

"You're carrying it too far. Nobody can understand it but you and a few other analysts who happen to use the same approach. Translate the results into plain English when you get the analysis done."

Peters looked horrified. "That's as absurd as a surgeon trying to explain a complicated operation to a layman, using no special terms.

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What could he say? 'I got a knife out and slit his stomach open. Then I clamped the skin and muscle back out of the way, and went in after his append . . . this bag of—' "

Flint nodded. "That's the idea."

"But all the fine points would be lost! The expert would have to skip *every detail that the layman lacked the knowledge to understand.*" Peters shook his head positively. "No. The only way to get the actual facts across is for the *layman* to study the matter until he acquires enough facts to *understand the expert's explanation.*"

Marcus Flint leaned forward, the knuckles of his hand resting on the desktop.

"Doesn't it dawn on you that experts are proliferating like rabbits in this country? Just exactly where is any layman going to *get the time to study fifteen hundred different specialties so he can figure out what all these experts are talking about?*"

Peters spread his hands. "That isn't *my* problem. Don't blame me. *I* didn't make the world."

Madame Sairo sat back blankly. As the scene faded, she found herself like a pearl diver who surfaces with a few odd-shaped pebbles and no pearls. What was wrong?

But even as she groped for the cause of the trouble, a new scene was forming.

Ah, now, this looked more hopeful.

"Yes," she said quietly, "I have it. This is a distant land, and they are building. It is a tall structure—"

The Kremlinologists and Pekingologists leaned forward intently. The government economists looked shrewd.

The new Assistant Secretary growled, "Took her long enough."

"*Sh-h,*" said his neighbors.

". . . Yes," Madame Sairo was saying, "this is a tower of some kind. It is a very ambitious project, but this nation is great. It is—"

Someone murmured, "China?"

Another whispered, "A new atom-test project?"

The Assistant Secretary stared around in disbelief, trying to pick out faces in the gloom so he would know in the future whose advice had come out of this crystal ball.

Madame Sairo jerked back suddenly from the globe. She gestured imperiously.

The overhead lights came back on.

She looked around the tensely quiet room, her expression serious.

"Gentlemen, I am afraid I must ask you to be very patient. You wish me to examine the next great world crisis. But there seems to be some difficulty here. I have been in contact with some events that appear irrelevant, and then with what apparently was a great *past* world crisis. Conceivably there is interference of some kind here. Or possibly, some symbolism I do not yet understand. If you will be patient, I will try again."

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Her audience quietly settled back.

She gestured.

The room lights dimmed.

In the crystal, a new scene seemed to swim into view.

But *this* seemed to be just a man and a boy, glaring at each other.

Patiently, Madame Sairo leaned forward.

Sumner Maddox said exasperatedly, "You look at the lives of outstanding men who've really succeeded in a big way, and you'll find that *most* of them got an early start. Now, I'm not trying to force you to decide what you want to do with your life. But you've got to decide for yourself, one way or the other, and pick *something*."

"But I *can't* decide," said Roger Maddox, looking baffled. "There just doesn't seem to be anything— It's all hazy. There's just nothing I want to—"

The elder Maddox grimaced. "Listen. Without half your opportunities or advantages your great-grandfather had already learned a trade and was making a living at your age. Now, no one expects you to do the same. *Your* generation can go to school till they're twenty-six, and—"

Roger Maddox abruptly flared up. "I *won't* go to school till I'm twenty-six!"

Sumner Maddox said placatingly, "I didn't say you *would*. I say you *could*. Anyway, that's a long way off. But you still have to decide—"

There was a brief tense silence.

The younger Maddox stared at a distant corner of the room. "Wait a minute. I see what's wrong. It used to be, that when someone was growing up, day after day he *saw* grown people at work. In Great-Granddad's day, you could *watch* what different people did, see with your own eyes how they lived, and what their work was good for. Then you could decide what you wanted to do, because you knew what the choices were. It was like stopping at a crossroads to decide which of three or four different towns to go to, when you'd already seen the towns, and knew what they were like. But now— Now it's like stopping at a crossroads to decide which of a hundred and seventeen different cities to go live in, *when you never really had a good first-hand look at any of them before*."

The elder Maddox frowned. "Well . . . you've got a point there. That's because things are more complex now. Each special type of work is harder to understand, there are more specialties to consider, and the grown-ups work in one place while the children are in school somewhere else. It's *got* to be that way, but—" He paused exasperatedly. "Now, how the deuce do we get around this? Let's see—"

The scene faded out. Before there was time to even try to evaluate it, another scene formed, and there were two men in uniform, in

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an office with a photograph of a long gray ship on one wall, and a photograph of what was apparently some kind of submarine on another wall.

Admiral Bendix ran his gaze down the list of officers and shook his head.

"I know every one of these men, and not one of them is fitted. For captain of the *Constitution*, we need someone exceptional. He has to have outstanding capabilities as a leader of men, plus unusual ability in all the skills of ship-handling. On top of that we need someone with the technical know-how to *comprehend the ship's drive*, so that he can get the most out of it and the technicians who handle it."

Admiral Hart leaned back, his hands clasped behind his head.

"We may need three men for captain, in other words."

"It has to be *one* man. The knowledge has got to be in one head when the clinch comes, because every bit of it is crucial. How can you decide, when you lack the knowledge to evaluate the factors involved? The captain has to make the decisions, and while he certainly doesn't have to know *everything*, he has got to understand the ship, the men, and the ship's drive. Unless he has the knowledge himself, he *can't* make the decisions."

Hart shook his head.

"We aren't going to find one man with all those skills."

"We've got to *have* one man with all those skills. He has to *understand* the technical limitations of the ship, and he can only do that *if he understands the drive*."

Admiral Hart sat up and looked Admiral Bendix in the eye.

"Do *you* understand the drive?"

Admiral Bendix looked flatly back.

"No. Do *you?*"

"No."

"But *we* aren't going to command this ship. Whoever does—"

Admiral Hart waved his head irritatedly. "Look, to honestly understand that drive, you'd have had to start at about age twelve, and follow just the right course of study ever since. But you'd have had to follow it by luck or by predestination, because at that time, back when you'd have had to start, *nobody knew this drive could be built*. Did you ever look in any of those books? Did you ever try to talk to any of the people working on that project? And in about fifteen years, the thing may be obsolete." He lowered his voice. "I hear the Esmer Drive is going great guns. Where are we going to find an officer who understands *that?*"

Admiral Bendix put the list down in disgust. "I suppose it wouldn't be too soon to start looking for one right now."

Hart nodded soberly. "But this still doesn't find us a man for the *Constitution*."

Exasperatedly, the two men went through the list again.

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Elias Polk was staring at the man across the desk. "Damn it, can't you explain your reasoning any better than that? You want the country to put a hundred billion dollars into something you can't even explain?"

"How do I explain it to you when you don't understand the concepts involved? Once you understand those concepts, the solution is intuitive. I know the answer the same way I know where water will come out when I tip a pitcher. It's *obvious.*"

"Let's go over it again," said Polk stubbornly.

Reginald Paxter slit the envelope, pulled out the glossy book advertisements, and glanced at the titles:

"Inverted Limits in Transient Field Problems"

"Operational Functions for Projected Relay Circuitry"

"Recent Developments in Kickback Ready-State Devices and Their Theory"

Paxter sneered. "Gibberish. Pure gibberish. Who would—" He paused. One more title caught his attention. His eyes lighted.

"Saro Integrals in Complex Space Matrices of Non-Orthogonal Form"

Eagerly he pulled over the order sheet and got out his checkbook.

"No, Mrs. Bennett," said the service manager with a hounded look, "it was the brake *lining,* inside the brake drum, that was bad. It was cracked, glazed—Before, all we had to do was *adjust* the brakes, that's why this time it cost—" The phone rang jarringly. "Excuse me just a minute. *Hello?*"

A familiar sarcastic male voice said, "Look, that starter you said you fixed. It doesn't work. When I tried to start the car this morning, it just groaned."

"Ah— Well, the trouble is, like I said when you were in here, your voltage regulator—"

"What's that got to do with the starter?"

"Well, you see, the generator puts electricity *in* the battery. The starter takes it *out.* The—"

"How did the *generator* get in this? Are you trying to tell me you've got to work on the *generator* now?"

"No, but the voltage regulator is—"

"A minute ago, you said the generator. Which is it?"

"The *regulator* decides what the *generator* output will be. If the regulator is bad, the generator can't put electricity in the battery. When you were in here, I was trying to tell you—"

"What's that got to do with the starter?"

"If your battery's dead, the starter can't turn the engine over."

There was a brief silence. "Well, there's *something* shot on this car. I had my brother push me all the way from Great Bend into town with the

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car in low-range, and the engine never caught once. I want that starter job done over, and this time find out what's *really* wrong."

The service manager seemed to see the bursting of innumerable bubbles before his eyes. "Look," he said, speaking carefully, "on your car, there's no rear pump in the transmission. You *can't* start it by pushing. You can ruin the transmission that way. You say you pushed it *all the way from Great Bend to town in low?"*

As the silence on the other end stretched out, he asked himself, didn't people know *anything* about the cars they drove?

Mrs. Bennett cleared her throat. "What did you mean when you said the brake linings were 'glazed'?"

Over the phone came a baffled voice.

"What's a 'rear pump'? Now . . . just wait a minute. What are you trying to pull, anyway? *What's the transmission got to do with the starter?"*

Madame Sairo sat back with a pained expression. She looked up from the globe, and glanced around the dimly-lit room.

"I am *trying* to learn of the next world crisis. I am concentrating on the next world crisis. I am trying to look into the future, and I am still making irrelevant contacts with past and present. Is there anyone here whose motives are not right?"

The Kremlinologists and Peking-ologists squinted dubiously at each other.

The Government economists looked pious.

The Assistant Secretary sat back and sneered at the whole fraud.

Madame Sairo adjusted the globe, and without much hope, tried again.

Dr. Greenhaven peered at the knowledge-growth projection, and then at the distribution-of-intelligence curve.

"We seem to be running into some difficulty here."

"Obviously," said the Projects Coordinator. "We now have teams of men attempting to do the jobs one man properly should do. This can only be carried so far. There is a delay each time knowledge must be transferred from one mind to another. If we have fifteen men, each with a different specialty, gathered around a table to help make a decision, we are in serious trouble. But we are worse off yet if we have a hundred and fifty men, each with his own specialty, gathered around that table. Knowledge is proliferating, Doctor. It is multiplying by leaps and bounds. If we aren't to have ten fragmented specialists where one stands now, what are we going to do about it?"

Dr. Greenhaven puffed out his cheeks, took another look at the charts, and said tentatively, "We must locate individuals capable of mastering this knowledge."

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The Projects Coordinator looked bored.

"And," said Greenhaven, "educate them at an earlier age. If possible, we must specialize sooner, educate earlier and more intensively. If possible, *we* must select the most capable, rather than leaving them to blunder around on their own. We will have to separate types according to aptitude and potential skill. A deliberate *fractionation of the race* into useful types."

The Projects Coordinator at once looked interested. "*Now* we're getting to the heart of the matter. Go on."

Madame Sairo watched the scene fade, and then hopefully looked into the crystal. *Now* she was seeing. But what did it mean?

There before her, as clear as if she were looking directly at it, was a tall something aimed at the sky, towering over the men in their coats of different styles and colors, working around the huge device.

Now it seemed to come closer to her, so that she was almost at the base of the device, and could see the people clearly.

Odd— They seemed to be separated almost according to physical types—or was that somehow the result of the similar clothes, similar facial expressions, and similar manner and air of those doing a particular job? Those at the—wiring?—seemed nearly all to be fairly tall and slender, with rather long faces, and penetrating blue eyes of an unusual cast, while those moving the machinery into place were mostly shorter, burlier types, and the others at the controls—

Puzzled, she leaned closer, trying to unravel the mystery, when a tall individual in a dark purple coat brushed past the—electronics men? —and then bumped a burly individual in a dark-blue jacket.

The purple-coated individual turned, holding the end of a long cable, and spoke irritatedly.

"Surry, fren?"

The purple-coated individual jerked his thumb back briefly at what looked like a large glistening maze of intertangled silver wires, set down into some kind of metal-lined pit, with large instrument panels nearby.

"Damn double-phased S-2 pit jerks more on hydrine than ever. Countercycles, shudders, creeps, unamit uknavit."

The blue-jacketed individual glanced around uncertainly, then his eyes widened. He seized the purple-coated individual by the arm.

"Damn doublefaced stupid jerk, eh? *Moron*, huh? Upurps gotchanerv. *Tagibak!*"

The purple-coated individual looked at him coldly. He wrenched his arm free. "Right, Bluejack. Jerks, creeps, counter—"

"Bluejack" whipped the end of the cable around and landed a stunning blow.

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The man in the purple coat staggered back, his hand to his face. Suddenly he screamed in rage.

Two tall, gray-coated individuals with a professorial air paused, frowning as if to try to get the scene into focus.

Another blue-jacketed individual, pulling a thick cable through a metal frame, whirled around as the man in the purple coat charged. Dropping the cable, the second blue-jacketed man rushed to the scene.

An otherworldly individual in orange and white looked down in pained surprise from an overhead ramp.

"Peace. Let us have peace. Brethren, what is the meaning of brotherhood if we cannot have peace? It is wicked to—"

Half-a-dozen purple-clothed individuals boiled out of the metal-lined pit and came on the run.

The two professorial individuals in gray glanced at one another in bafflement.

A short plump man in a jacket, striped like black typewriter ribbon alternated with red tape, burst out of a little cubicle in the midst of a maze of pneumatic tubes, and still clutching a rubber stamp, a crumpled form filled out in quintuplicate, and a thick book with his finger holding the place, raced onto the scene.

"*Stop!* This voids the contract! Forbidden on worktime! *ARBITRATOR!*"

More blue-jackets were appearing from everywhere. One banged into a black-coated worker in his haste, and got rewarded by a smash over the back of the head with a socket wrench three feet long.

"There," said the blackcoat, beaming. "Stuckup bluejacket! Lectricity! Watsowunifulbout lectricity? I'll lectricity the sonsa—"

His voice choked off as a length of cable whipped around his neck from behind.

A plump individual with a pill bottle in one hand tore down the overhead ramp, his pastel pink coat flapping behind him.

"Here!" He shouted, "Let's *ARBITRATE* the differences! Friends, FRIENDS, let's SPLIT THE DIFFERENCE! The other side DIDN'T MEAN IT! They're *reasonable!*" He looked down at the boiling melee of bluejacks, purps, and blackcoats, then twisted the cap off the pill bottle, and shot three pills into his mouth. He chewed desperately, stuck the bottle in his side pocket, and waited till an air of calm assurance passed over his face like a mask. He pulled a tiny microphone on a cord from his pocket, plugged it into a socket on the rail of the ramp, and his voice seemed to come out from everywhere, calm, persuasive, assured.

"FRIENDS, THIS IS A MISUNDERSTANDING. *THEY DIDN'T MEAN IT!* THEY WANT TO BE *FRIENDS*. WE CAN SETTLE THIS BETTER—"

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A blue-jacketed figure popped out of the mob, snarled, "Shutup-jerk," and held a length of dangling cable near a small metal box on a pole. There was a large jagged dancing spark, a roaring noise, and then silence from the public-address system.

The bluejacket grinned, then thrust the cable against the leg of a purple-coated individual who had another bluejacket by the throat.

On the overhead ramp, the pastel-coated arbitrator looked puzzled, but spoke on with invincible assurance as a horde of burly individuals, their coats striped vertically like zebras, intermingled with the rest of the strugglers and began laying them out in all directions indifferently, only to be set upon by others, their zebra-stripes running horizontally.

In all directions, on high and low levels, struggling sets of individuals could now be seen pushing each other over the edge, choking, kicking, biting—

On the ramp, the arbitrator looked around, and paused. Worry crossed his face. He pulled out the bottle and tossed another pill in his mouth. He glanced at his watch. Ninety seconds passed and he was still worried. He took a last look around, jammed the bottle in his pocket and yelled, "POLICE!"

Below, the mob slammed into a wheeled machine, which mounted an insulated man-carrying stand on a long jointed metal arm.

The arm swung around sidewise, striking a tall heavy wire grid holding glistening beadlike objects of varying colors, shapes, and sizes. A large section of the grid wrapped around the stand and the metal arm. There was a loud sizzle, then a sheet of flame roared up, followed by a cloud of boiling smoke.

A dazzling spark, or blazing point of light, rapidly ate its way up the shiny cable into which a number of the grid wires fed, and traveled along the cable up the side of the towering device.

The arbitrator's gaze followed the climbing spark in bafflement. How did you split the difference with a thing like that? The facts of the matter began to penetrate his pill-given assurance. He glanced around.

A little group of scowling men in checked black-and-blue jackets, followed by a host of blue-clothed men armed with gas guns and billies, advanced at a fast walk down the ramp, trying to make out what was going on, and then one of the men in checked jacket suddenly spread both arms, stopping those behind him. He stared up at the dazzling spark, just disappearing into the towering device, and suddenly grabbed a portable loudspeaker from a man behind him.

"She's going to blow! RUN! RUN FOR IT! *SHE'S GOING TO BLOW!*"

From the tall device, a feather of greenish smoke spurted out.

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The men looked up in horror.

The greenish feather gradually grew darker and thicker. It came out with more force and began to reach farther out.

The mob boiled away in all directions, dwindled into little groups of men jumping off low towers and climbing up out of sunken pits, to sort themselves in like groups with almost a family resemblance, and sprint away in a desperate rush.

From the tall device, a green jet now reached out, with a whitish flame that lit the totally abandoned machinery below.

The whole scene began to dwindle, growing smaller and more distant, till it faded out entirely.

Madame Sairo leaned back wearily. She sat in silence for some time, then shook her head.

As the bulk of her audience waited hopefully, and the Assistant Secretary looked on cynically, Madame Sairo spoke with considerable doubt.

"I am not sure our thoughts are all in harmony. It seems to me there has been some sort of interference.

"I have seen what was apparently remote antiquity. And I have looked upon a number of seemingly unrelated more or less current scenes which, however, now *do* seem to have some sort of connection, after all. And finally I have seen what I cannot believe was really the *next* world crisis, which is what you wish to know about; but then, if you are not in harmony, as I have warned you, it may confuse the issue under certain conditions. However, if I understand this, the sooner you know of the danger, the better."

Madame Sairo signaled to her assistants.

The overhead lights came on, and the blond boy in white wheeled away the big crystal.

"Now," said Madame Sairo, "I am going to tell you some ancient history. And let me remind you of the saying, 'History repeats itself.' "

At that moment, Elias Polk was studying the latest report on the Esmer Drive. This report was even worse than the one before. This one seemed so devoid of any human connection that Polk's mind could get no lasting grip on it.

Exasperatedly, he shoved the dictionary aside, flattened the report on his desk, and reminded himself that a human being on the other end of a pencil had originated the first version of this thing, and yet here it was, presumably in his own tongue, and he couldn't understand it.

Polk shook his head as a related thought occurred to him.

Science and technology were repeatedly branching, so that there were more separated specialties in each individual branch all the time.

All the curves showed that progress in each individual branch of

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science and technology was skyrocketing.

It was natural to suppose that this meant unlimited progress.

But what about the *connections* between the individual scientists, technicians, and people generally?

By shoveling coal fast into the firebox of a steam engine, and plotting the resulting speed, it would be possible to make a curve that rose and rose, heading up toward infinity, until the safety valve blew, or, barring that, until the metal of the boiler lost cohesion and let go in a hundred different directions at once, and the process came to a stop.

Polk picked up the report, and took a long hard look at it.

"It would be possible," he growled, "to carry this so far that nobody understands anyone in any other line of work, and *then* what will we have?"

He paused, frowning. Hadn't he read, or heard, somewhere, about some such thing?

Then he shook his head sourly, and tossed the report back on the desk.

Man was *headed* for the stars.

But he would have to be careful he didn't wind up in the Tower of Babel instead. ■

In Times to Come

Next month's lead yarn will be "The King's Legions," by Christopher Anvil—with a cover by Kelly Freas showing the highly imaginative kind of super-duper armor dreamed up by the Symbiotic Computer! Anvil's triumvirate of spacemen, who got mixed up on Paradise (that was its name—not its character) some while back, have returned in force. Want-generator and all.

You may recall that they found that the want-generator didn't quite solve all problems with the ease and élan it was supposed to. This time Paradise has troubles not only with the somewhat imaginary Oggbad the Fiend—but with the strictly nonimaginary pirate ships of Maury and with the Space Force. Both of which Forces don't seem to take well the want-generator effect—

Which might not have been hopelessly bad if it weren't that that remarkable symbiotic computer had its own ideas of what should be done. The fact that the three men didn't agree did them relatively little good—the computer could stick their necks out much faster than they could try to pull them in.

THE EDITOR

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The Misers / William T. Powers

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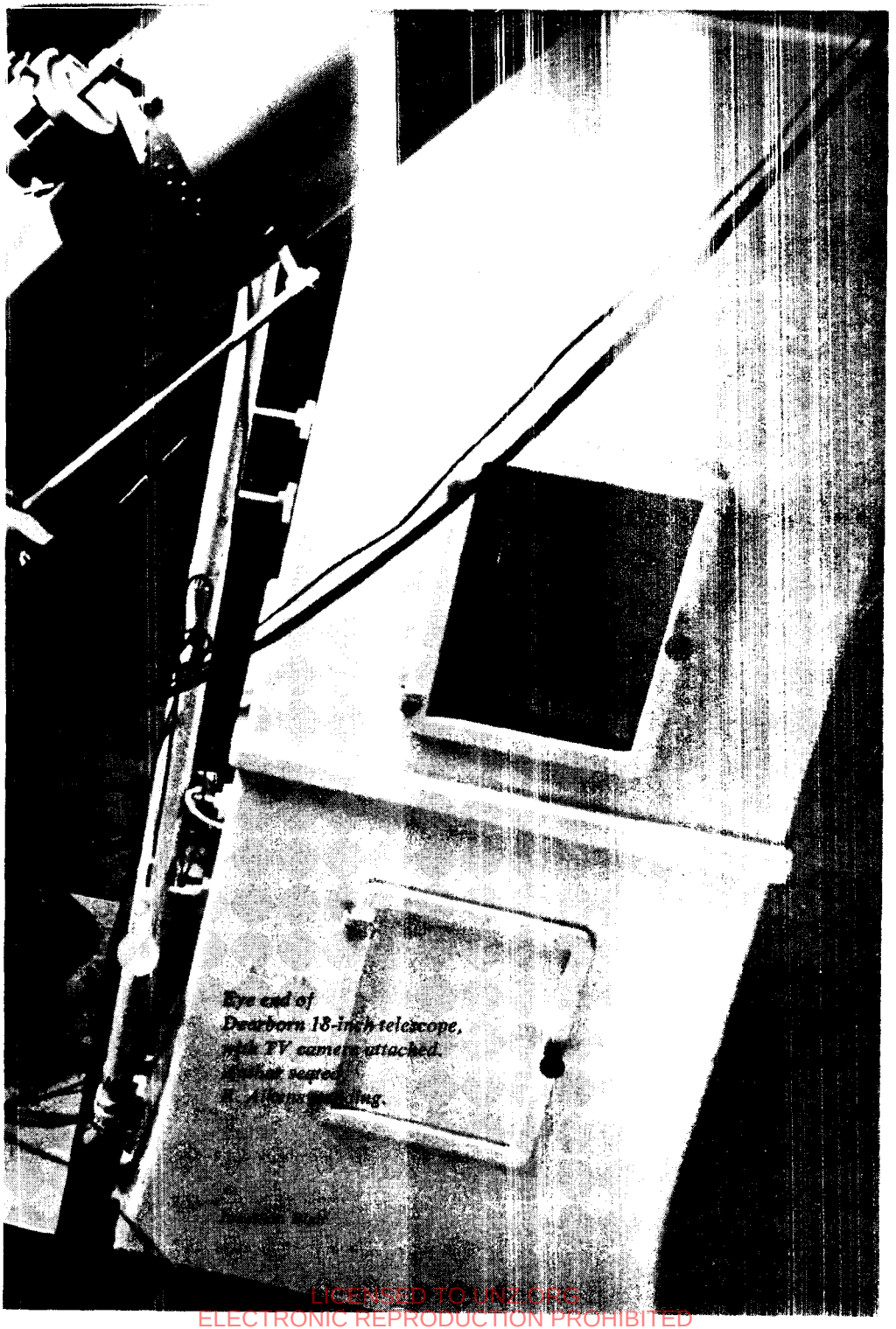

Eye end of Dearborn 18-inch telescope, with TV camera attached. Alcohol seated R. Allen standing.

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This is the longest one-piece fact article we have ever run—over thirty pages. The reason, however—as you'll find as you read—is that it sounds like something out of one of Bill Powers's own stories—or some other science-fiction story. We've been talking about electronic telescopes for years—Bill Powers and his associates aren't just talking; they're building 'em!

If all the photons that enter an astronomer's telescope in the course of a night's observing were laid end-to-end, most of them would turn up missing. Even the very best red-hot sensitive astronomical emulsions, coddled, baked, pre-exposed, and bathed carefully in the best USP chemicals, come up with a record of about one percent of what went on during the exposure. It used to be worse—last year, the guesstimate was one tenth of one percent.

You really can't appreciate how frustrating this is until you've tried to make a long-exposure photograph, say about February 12th, when the dome is holding nicely at five above zero, all the grease has turned to taffy in the telescope controls, and one careless sigh of ennui can render the guide eyepiece so opaque that you have to take it downstairs to get it cleared up again.

One struggles about the dome in four layers of clothing getting the camera set up, loading the plate into it, and aiming the tube in the general direction of the target field. With the telescope aimed, one has to heave the observing ladder around, climb up, and lean out over the telescope to see into the finder eyepiece. Cantilevered out into space one then consults his field-finding chart, manipulates the slow-motion buttons, holds a flashlight, and hangs on with the rest of his free hands. As often as not, the field-finding chart—a penciled sketch representing the view in the finder when one is centered on the invisible object he is to photograph—turns out to contain two or, at most, three stars that can be seen.

One jogs the telescope this way and that, searching for the exact pattern on the chart, finding lots of fields that almost match, but none that are quite right, until gradually the telescope has crept five or ten degrees away from its starting point, which was initially correct within a tenth of a degree or better. Repressing the fatal sigh, one climbs down

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and resets the telescope with reference to the dials, and returns to the finder. There is the field, right in the middle.

It is necessary to find a guide star, which one has usually picked out beforehand, and this involves moving a sort of high-power periscope-microscope in and out and back and forth in the camera until the guide star appears, or one just like it. Since the guide-eyepiece periscope thing magnifies greatly, its field of view is minuscule—most of the time, one can't see anything at all in it, so that discovering any star, much less the guide star, is largely a matter of persistence and luck.

Finally the guide star swims into view, a pulsating, shivering, amoeboid blob illustrating every disadvantage of earth-based astronomy, and one gratefully brings it onto the cross hairs with the guiding-speed slow-motion buttons. Very high magnification is used in order that the slightest deviation of the star from the center line of the eyepiece may be instantly—well, eventually —corrected by the alert astronomer. All is ready to begin the exposure. Remember that light rarely makes its way through sheet metal, so pull the dark slide from in front of the film *before,* not after, the exposure.

Attentive and alert, one settles down to keep the star centered for an hour and a half, his upper lip carefully protruding beyond his lower lip so his breath goes down, away from the eyepiece. By this time both feet are cold.

The blob wavers about, and every now and then one thinks that the average position has shifted, and nudges the button. Majestically the earth wheels, the telescope drive almost compensates, and soon one realizes that he is off the sliding seat, crouched in an excruciating position. One step on the ladder is just too low, so that one has to stand on tiptoe to see into the eyepiece, while the next step up requires that one stand with his knees bent. If one steps sideways so that his legs can straighten, he must support himself with one hand, leaning at an angle. The inexorable motion of the telescope as it "follows" the stars eventually forces one to push the dark slide back in, climb down, and move the ladder. Then back to the eyepiece in blessed comfort—pull the dark slide again!—for another fifteen minutes or until one notices that his legs are aching and he is no longer sitting down.

Finally, almost two hours later, a shivering, aching, half-blind hypnotized astronomer stumps about the dome on his ice-block feet, closing everything down—that second exposure will just have to wait—and exits into the beautiful warmth and light of the observatory. At this point, the dark slide should be *closed.*

The plate in its holder warms toward room temperature for half an hour while the astronomer also thaws, and then it's ho for the dark-

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room to see what we have. Did he turn off the sidereal drive? Of course he did. He always does. And he always gets his coat on again, climbs the stairs, and verifies that the drive is, and was, indeed, off.

So ho for the developer and six centuries of absolute darkness waiting for the timer to ding, then another two centuries washing, and two more in the hypo before the lights can be turned on, then five more before it is really truly safe to look, and finally the negative, dripping into the sink, is held up before the viewing glass.

Hooray, lots of little dots! Nice, round, hard little dots just as if the telescope drive had been perfect and the atmosphere still and the astronomer downstairs drinking coffee all the time.

This is *not* the time to remind the astronomer that if the emulsion had shown the same loyalty to the cause and the same vigilance as he himself had been displaying for two hours, the exposure could have been finished in approximately fifty-six seconds. It's better to change the subject.

The 200-inch telescope at Mount Palomar was built not to provide a more detailed view of the universe, but to put as much glass as humanly possible in the way of incoming photons. The problems of figuring a mirror, that would scarcely fit into a two-car garage, and of mounting it, so that the figure would stay the same no matter where the telescope pointed, have never been solved. They have only been coped with. The final solution can come only in gravity-free orbiting telescopes—the gigantic space telescopes of the future. The 200-inch instrument doesn't even come close to reaching its theoretical resolving power, even on nights of perfect seeing, which is about 0.02 seconds of arc or a penny 100 miles away, and it doesn't look as if any earth-based telescope of that size ever will. The 200-inch is, and was meant to be, a light-bucket, built to make up for the near-blindness of photographic film, coaxed night after night into working by bands of light-misers bent on salvaging the largest possible number of the oldest possible photons, either by delicate science or by force—whichever works best in a given instance.

The art of astronomical photography has probably received more attention than the design and construction of large telescopes—for one thing, it's easier to find funds for taking pictures than for buying large chunks of hardware. It is possible, for example, to measure the brightness of stars by measuring the amount of spreading of an image, which increases with brightness, provided that one is careful to correct for atmospheric absorption; and controls the temperature of his film and the exposure and the precision of focus; and develops with freshly made solutions concocted with exceeding precision, maintained at the

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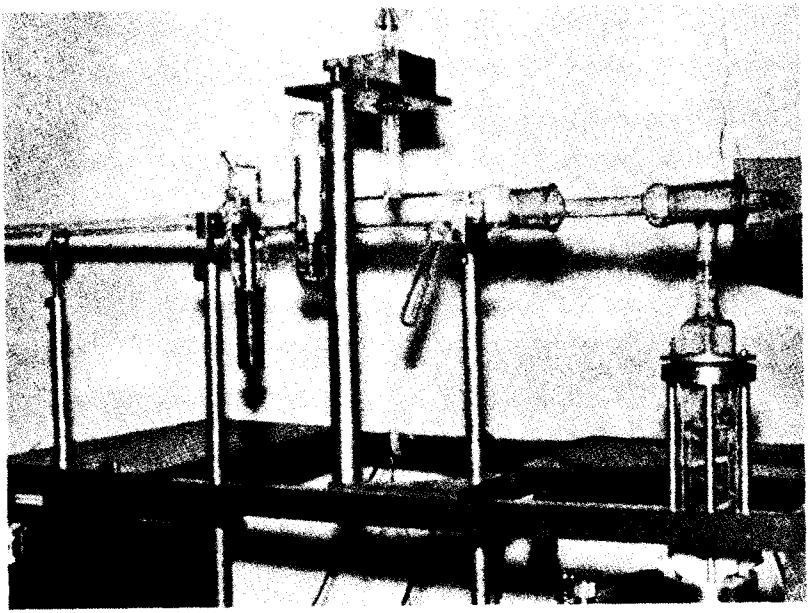

Lallemand Tube. Clumsy but it works—it's sensitive.

correct temperature, and applied the same way every time; and sticks to rigid washing and drying schedules; and wears his lucky sweatshirt.

Many things are possible with photographic film, but one would never know it from studying its properties. Everyone has heard that film responds logarithmically, not linearly, to light. A developed negative that passes half as much light as another negative has been exposed not to twice as much light, but more like ten times as much. Well, that's not too bad—on semilog paper, a logarithmic curve is a straight line, so calibrating ought to be easy. It would be, if one actually got a straight line when plotting sensitivity curves.

What one gets in practice is an S-shaped curve: as light intensity increases from zero, at first nothing at all happens; finally, the curve grudgingly departs from the zero line and heads upward, joining some reasonably logarithmic curve for a while, and then it gets tired and slows down, eventually refusing to acknowledge any more light. In addition, one gets different curves depending on whether he gathered the photons slowly or quickly, even though the same total number were presented to the film. Astronomers, who may use exposures ranging

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from 1/20 second to 20 hours,* are naturally concerned with any dependence of calibration curves on the length of time it takes to accumulate enough light for a good negative.

Oh, one may well sigh for a way to detect light that is efficient, linear, repeatable, and neat. As a matter of fact, such a way has been around as long as, or maybe longer than, photographic film—namely, the photoelectric effect. Actually, I am speaking of the vacuum type of phototube which did come later. A vacuum photocell will respond to light with rigidly perfect linearity: twice as much light, twice as much current—exactly twice. The output can be read off a meter, or recorded directly onto chart paper, without a single minute spent dipping one's sleeve into the developer. If you accidentally expose a photocell to light before you meant to, you don't have to rush downstairs to get another one. You approximate your calibration curve with a straight line on ordinary graph paper, and it goes *through* most of the points, instead of wandering along near the middle of the scatter.

There's just one problem—beside that of building an amplifier without any noise of its own, and chilling the photocell with dry ice so it won't leak all kinds of current when there's no light and so that it *will* tend to accumulate frost even out of the air over an Arizona desert—and that is the photocell has tunnel vision; it can't tell *where* on its sensitive surface the light is falling, so it can be used only on one point at a time. If you want to measure the brightness of a star, you have to center the image on a tiny aperture behind which is the photocell, because the photocell can't tell which photons are coming from the star and which from the surrounding background of light that is always present in the night sky. The more skylight you can exclude, by squeezing down the size of the aperture, the fainter the star you can detect, and there you are back with your eye to the guide eyepiece again, freezing.

Photoelectric surfaces still aren't perfect—they let some 65% of the photons escape notice, but that's a vast improvement over 99% or 99.9%, particularly if you compare how many are collected—35% against 1%, to compare the absolutely best examples of film and photosurfaces. In terms of exposure time, that's a real gain—oops!

Well, yes, it is possible to take a time-exposure with a photoelectric cell, despite the fact that each photon that is going to do anything at all kicks loose its electron and dies on the spot, and even though the electron may exist as a free soul only for a billionth of a second. Two things make this possible—digital counters, and electron multipliers, in the opposite order.

*It's possible—figure it out. You won't believe it, but you're right.

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Electron multipliers are nifty little structures that are inserted into practically every modern astronomical photocell. When an electron is dislodged by the energy in a captured photon, it is directed into this multiplier, and out of the other end comes a burst of anywhere up to 2 million electrons. It's done with mirrors. Each electron slams into a cesium-coated plate and knocks out some 6 or 7 electrons. These are caused to fly through the vacuum to hit another plate, and we have 36 to 49. Each of these is hurried on to collide again, giving 216 to 336—you can see that maintaining the multiplication ratio exactly constant has a certain bearing on calibration of such a device. After nine such collisions, one has rather a handful of electrons. But in a well made multiplier the handful arrives in a tight little bunch, so that a sharp jolt of current comes out of the multiplier for each photoelectron that went in—sharp enough to be detected and counted. And that's how time exposures are carried out with photocells—one keeps the star centered in the aperture while the counter jots down the arrival of each photoelectron, keeping a cumulative total.

There are two reasons why time exposures are required even with photocells. The first is that light-intensity is counted in photons *per second*, so arrival of a single photon doesn't tell anything about how bright the source was: one must count photons for a known time, and then divide the number of photons by the time to get intensity. Even ordinary photocells work this way, but the computation is done automatically by the moving parts in the indicating meter, which can't respond to each electron and so indicate the average rate at which they are coming.

The second reason is more complicated. A light source delivering 10 photons per second to our photocell doesn't send them along like clockwork, 1 each tenth of a second. During one 1-second period, we might actually receive only 7 photons, and during the next, 20, and then 5, and then 10, 11, 9, 9, and 16. Clearly, a 1-second reading would be almost certain to give a wrong result. In fact, the variation to be expected in counting random events is simply the square root of the number of events—the total number—counted. If one counts photons averaging 10 per second for 1 second, he can expect that half of the time he will get a variation within 3.16 counts, or 30% error. If he counts 10 seconds, he will be likely to get something between 90 and 110, for 10% error. If he waits 100,000 seconds, his error will be only the square root of a million, or 1,000 counts, or 0.1%. The error can be more, or less, since this is statistics, but these figures are reasonable predictions of errors that one may expect, and they check out nicely.

There are other sources of sta-

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tistical variations: the best photosurface responds, on the average, to about 1 in 3 photons, but it does not go *tick, tick, BANG, tick, tick, BANG,* but more like *tick BANG BANG tick tick tick BANG tick BANG tick tick tick tick . . .* the "ticks" are photons arriving and the BANGS are the photoelectrons generated that actually make it out of the metal oxide surface into the vacuum, where they matter. But whatever the source of random variations, time exposures are the only way to average them out.

Photosurfaces are made so as to have only the most slippery hold on their free electrons, so that escape is as easy as possible. Unfortunately this means that sometimes, due to thermal agitation primarily, the photosurface will let go of an electron without being able to blame it on a photon. These "thermal" electrons are counted right along with the photoelectrons, and they must be sorted out.

Since all electrons look alike to nonelectronic entities, the only way we can do this is to stop up the hole in front of the photocell and take a long count of thermal electrons alone, to see how much to subtract from the signal-plus-thermal total we got from the star reading. Then we do it all over again, of course, with the telescope aimed at a blank patch of sky near the star, to see how much more to subtract for skylight photons. With care, one can measure starlight intensity to about one-tenth percent this way. And no messy solutions—just a lot of expensive electronics.

It is possible to take advantage of the photocell's higher attentiveness to photons, you see, even though we can only look at one object at a time. Before we go on to see how one gets around this point-at-a-time problem, it might be interesting to ask just how much room for improvement there still is, both in photocells and in photographic emulsions.

The absolute ultimate in sensitivity will be determined, naturally, by the incoming photons themselves, and particularly by their random arrival rates. Even if one could record the reception of every single photon with perfect fidelity, one would still need time exposures, simply because to tell whether one has a star plus background light or just a statistical fluctuation in background light that looks like a star, one must count photons until the random errors are smaller than the difference between star and sky. Aside from this limit we can never exceed, what about improvements in sensitivity?

The photocell is already doing pretty well. All we can hope for is to triple its sensitivity, and certain processes, such as hole-electron production in semiconductors, may well provide "quantum efficiencies" close to 100%, when we can learn how to detect the charges before they recombine. So that's the limit for photocells—something so close

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to 100% efficiency that it doesn't matter. Photographic film, however, is another matter.

I don't really know how photographic film works, and people who know a lot more about it than I do aren't really happy either. In general, though, we can say that when a photon is absorbed in a way that means business, something happens to the chemical status of the constituents of the film, so that exposure of the film to a developing solution will convert the latent image to a real image. The latent image, whatever the chemical processes involved, represents a collection of "grains," the least being a single grain, that is essentially removed from any further participation in photon-recording as soon as the magic interaction with a photon has taken place. That means that a new photon falling on the same place in a way that might work anywhere else on the emulsion will certainly be ignored, instead of only probably.

The result is that when one focuses the image of a star on a small patch of emulsion, that patch grows steadily less sensitive as time progresses, because more and more of its potential for responding to light is being used up. (This is the reason for the logarithmic response.) In any practical sense, 100% quantum efficiency is simply not possible for photographic film! The only way to get anywhere close to it would be to use such short exposures that the film was only faintly exposed, and here we run into the other kind of defect: you have to expose film to light for a considerable piece before seeing any discernible density at all. That means that efficiency will approach zero either for very short or very long exposures.

One can get around the low-light-level failure to some extent by prefogging the film, deliberately exposing it to a uniform light-source just enough to get the film "loaded" with photons to the point where it will start responding sensibly, but this process, of course, introduces a lot of fake grains, which is the equivalent of raising the noise level of the film and which in turn requires longer exposures just to tell the real stars from the ersatz ones. For reasons like this, it may well be that the quantum efficiency of photographic film is approaching its ultimate limit already, even though only 1% efficiency can be achieved now, by mad geniuses of the darkroom. I hope I am wrong. So far there isn't a work of art on earth to compare with a lovingly made photographic record of one of our galaxy's great cataclysms of gas, dust, and stars.

Back, however, to stern reality. The light-misers will never let maudlin sentimentality save astronomical photography if they can do the same things better in other ways. The other ways are already well-launched.

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Perhaps the best introduction to "other ways" is one of those lovely concepts which has all the elements of simplicity and elegance that one demands of a truly creative solution to a problem. I speak of the Lallemand electronograph, named after an ingenious French astronomer of the same name. Suppose one props up a sensitive photocathode at one end of a vacuum, and a piece of photographic emulsion at the other, and arranges the situation so that all electrons kicked out of one point on the photocathode are constrained to arrive at precisely one corresponding point on the piece of film. This can be accomplished by use of a moderately strong magnetic field.

Now, if we focus an image onto the—flat—photocathode, each little element of the image will be converted into photoelectrons with respectable efficiency, and the resulting "electron image" will be slammed into the photographic emulsion. By careful selection of electrode voltages, one could prob-

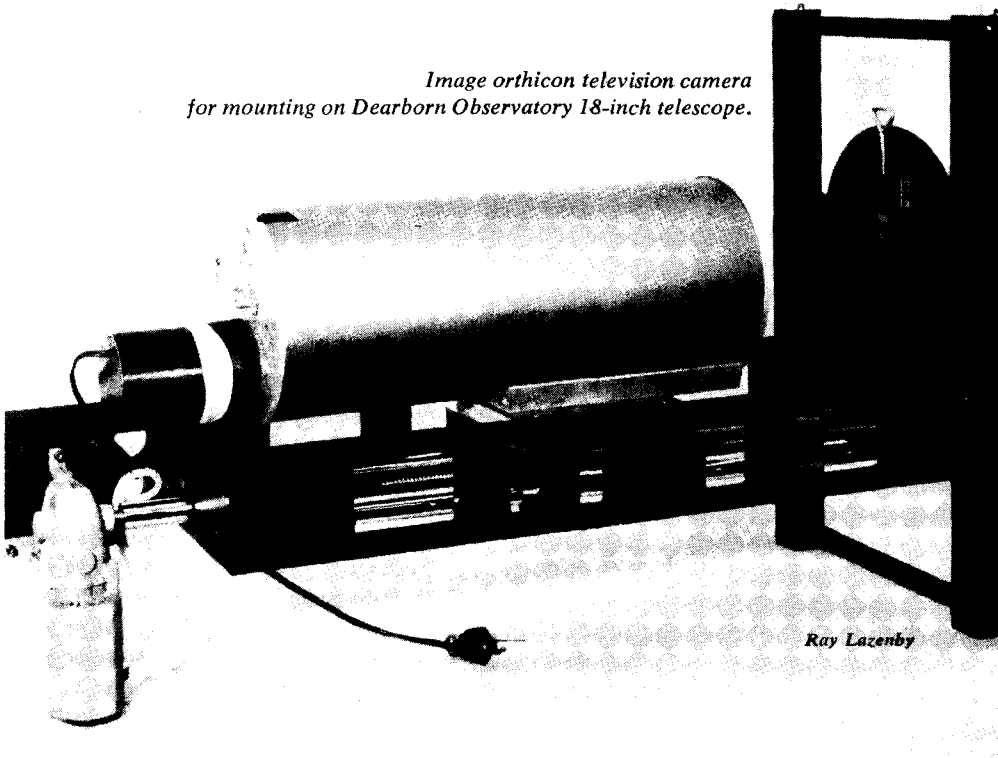

Image orthicon television camera for mounting on Dearborn Observatory 18-inch telescope.

Ray Lazenby

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ably cause these photoelectrons to punch millions of tiny holes through the emulsion, but more reasonable designs merely see to it that each single photoelectron exposes somewhere between one and one hundred "grains" of the film.

Here, it seems, is perfection! Every single photoelectron is made to produce at least one developable grain, and we may take full advantage of photoemissive sensitivity and still get two-dimensional pictures too, instead of just measures of one point at a time. In fact, this type of device has proved to yield the best combination of geometrical resolution of detail and brute-force sensitivity known to man. The Lallemand tube has been set up as a sort of standard of perfection against which one measures his fumbling attempts to get at the problem in other ways. The reason that other ways are still being investigated is the reaction of horror and disbelief which is common among those who are seeing a Lallemand tube for the first time.

If one visits an observatory in which the Lallemand device is being tested—most likely during the day because that is when one finds the largest number of astronomers present—he will find the Lallemand tube not on the telescope or in a cabinet, but on a pumping stand, looking like a biochemical apparatus for decoding RNA. The forepump chugs cheerily away, the stringers of glass tubing gleam in the fluorescent lighting, the vacuum gauge indicates a micron, or so, of pressure from gases departing from various surfaces. It looks as if they are just getting around to building the thing, despite the fact that you have seen pictures of last night's results. As a matter of fact, you are right—the pure Lallemand tube, the real thing itself, must be constructed all over again every day. Its only really annoying defect is that using it destroys it.

It's not the kind of destruction that's fun to watch, but a subtle effect that you learn about the hard way. The film poisons the photocathode. It's almost as if these two sensors from different sides of the tracks sense the life-and-death battle that is getting under way, and the one that is losing attacks out of desperation. The emulsion, unfortunately, is mainly organic, and is so built that gases love it—that is, until it gets into a vacuum. Then an incredible volume of junk billows forth, and if there's anything a good photocathode can't stand, it's matter raining down on it out of a vacuum.

So, you begin by making the photocathode, a process that takes several hours and a lot of equipment. Then you seal up a bit of film in an ampul—in the dark, of course—which you insert into a sidearm of the vacuum apparatus and seal off. Then you bake the system and get rid of the gases which were introduced, for several more hours. Then you break the ampul with the film

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in it—in the dark, by knocking it with bits of iron, using a magnet—and move the film into place, still pumping madly. Then you seal off the arms of the vacuum system you don't need, the pumping line last, and rush upstairs with the whole thing in the light-tight box and mount it in its magnetic focusing coil and connect the accelerating electrodes to their power supplies.

If, after your twelve-hour stint in the laboratory, you find that the sky is still clear, you take one—count them, one—exposure, wrap up the tube, cart it downstairs, BREAK IT OPEN to get your piece of film out, and go develop the film while the atmosphere completes the job of turning your nice photocathode into a useless film of crud. I think it is safe to say that the only Lallemand movies that will ever be made will be of the rotation of galaxies. One just has to admire men who will go through this to get a picture: they are the saints of astronomy. And like most saints, they give us a vision of the promised land without explaining how to make it practical.

One's first impulse, of course, is to protect the poor photocathode—one doesn't just toss off a good photocathode every day like a pie, even saints. Hiltner—Yerkes Observatory—and Kron—Lick—have both built devices which seal off the part of the tube containing the photocathode, except during exposures, and which carry magazines permitting several exposures in a row, and—of importance to certain fussy types—which work. The problem of poisoning is, as much as any reasonable man could ask, eliminated in both these approaches, but as happens far too often to be attributed to mere chance, solving the outstanding problem only exposed others, equally practical and much harder to solve. The main one is that of magnetically focusing the photoelectrons onto the corresponding parts of the emulsion.

If our society ran on D.C., the problem would be much easier to solve, but unfortunately power comes in the form of currents which reverse 120 times per second, varying in between from zero to max and back again, and this means that any center of civilization, even an observatory, is immersed in an alternating mess of magnetic fields, the very same type used to focus the Lallemand tube. It doesn't do much good to focus a tube down to a microbe's muscle if the place where you are focused shifts 120 times per second. Also, the earth has a nice steady magnetic field, but the stars keep moving, so during a long exposure local magnetic field direction seems to change as the telescope moves, and what do you do about that?

One thing that you do is to consider brute force, and a physicist at Dearborn Observatory, Jay Burns, is about to take this route with a gleam of pitiless purpose in his eye.

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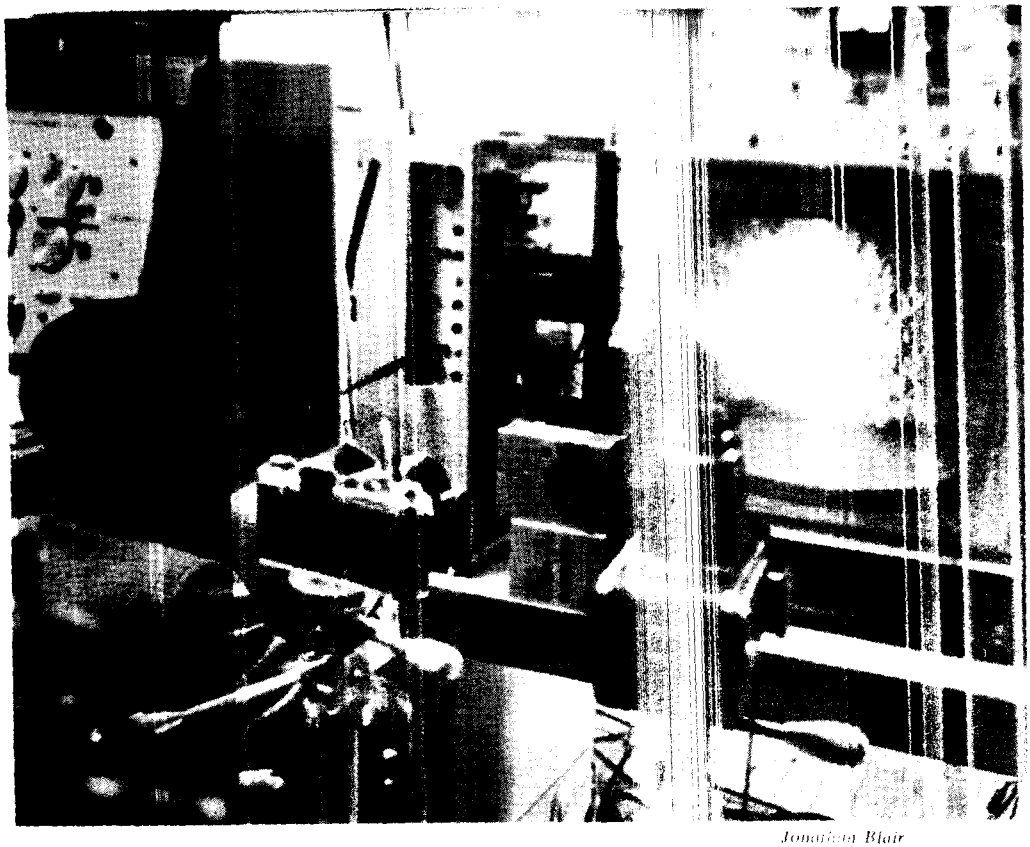

Jonathan Blair

This is for [illegible] picture is taken in daylight, and [illegible] is an image of the moon that [illegible] is looking at. Deep red filter, on [illegible] system, 30 frames per second. About 2:00 p.m.

So what, he says, if you have a few gauss floating around? Let's just jack up our focusing fields to the point where a feeble civilization using a trillion kilowatt-hours of A.C. power per year, or a little permanent magnet like the planet Earth, can be ignored. Let's stick the thing in a superconducting electromagnet and get on with the real work. If you crowd the lines of force close enough together, you can forget about electron trajectories altogether—the electrons will be restricted to fine little parallel filaments no matter what their lineage, and their future is strictly a straight line from A to B.

Burns isn't going to use this approach in an electronograph type of tube like Lallemand's, or Kron's or Hiltner's, but it's an idea. What he *is* going to use it for gets us away from the transitional device Lallemand thought up into the devices of the future.

Let's go back to the front end of a Lallemand tube, with a photocathode busily converting photons—

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sometimes—into photoelectrons. If we now magnetically focus these electrons not onto a piece of film but onto a phosphor, being careful to preserve one-to-one correspondence between the original image and the final electron positions, each electron will—quite often—excite the phosphor, which in the process of calming down again, will emit upwards of a hundred light photons from a corresponding spot on the phosphor.

Unfortunately for this dandy idea, the outgoing photons have no sense of direction. They are just as likely to head back toward the place where the photoelectrons came from as to pass out of the tube where they can be seen. To prevent this waste, a thin aluminum coating is often placed over the phosphor, thin enough that photoelectrons accelerated to 20,000 volts or so can penetrate it easily, but thick enough to reflect light. We are still left, however, with the output photons departing over a 180° arc.

Ultimately, we want to get these photons onto some kind of recording surface, like photographic film: the factor of 100 gain in the light amplifier would seem approximately what we need to make up for the 1% peak efficiency of available films. So we get a nice fat lens, relay the image from the phosphor to the film, and there we are—nowhere. A "nice fat lens" that will gather any impressive fraction of the light exiting from the phosphor is incredibly hard to buy. In fact, to collect 20% of this light, one needs two lenses, back-to-back, each having an f-ratio of 0.75—that is, the focal length of the lens is only three-quarters of the diameter of the lens. Not only that, the lens must have a large enough diameter so that light from all parts of the phosphor—not just the center region—will pass through to the image with the same efficiency. Any camera buff will recognize that we are talking about the outer boundaries of the state of the optical art. And this gets us 20% of the light, so we are left with a light-gain of 5, not 100. The rest of the photons go sailing off to collide with varieties of matter that couldn't care less.

Jay Burns' strong-arm focusing will see to it that photoelectrons all arrive at their destinations still properly sorted, but we need a much better way to collect the electrons and record them. One such method, which just about reaches the limit of optical methods, involves the use of fiber optics.

When light enters the end of a small glass fiber, it cannot get out if it fails to escape on the first bounce, because at the glass-air interface the light will be totally reflected. The light goes bouncing back and forth down the pipe until it reaches the other end, where it exits at an angle similar to the angle at which it entered. If we pack millions of these fibers side-by-side, seal them

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together in a second kind of glass that still permits total internal reflection to occur, and polish the ends of the bundles to optical flatness, we have what is called a coherent fiber bundle: coherent because each point at the input side is connected to the exactly corresponding point on the output side, and bundle because it's a bundle. Modern technology permits the manufacture of coherent bundles consisting of fibers considerably smaller than 15 microns in diameter—just how much smaller is classified—so that it is possible to transmit images having as much detail in them as any large telescope can provide.

For our purposes, the most important thing about fiber optics is their "angle of acceptance"—the off-axis angle at which light will remain inside the pipe; this, together with the optical transmission of the glass, permits around 40% of the light from an image-amplifier tube phosphor to be collected. And since the inside of the bundle is in vacuum, with the phosphor on it, and the outside face of the bundle is in air, we can simply press a piece of film against it, giving the light diverging from the little fibers no chance to spread, and end up with something like a 40% record of the photoelectrons. With a 30% efficient photocathode, this gives us an overall light-capturing power of 12%. Not bad. When modern technology gets within a factor of eight of perfection, you know that a bunch of people are about to be out of jobs.

HOWEVER, as if I had fooled anyone, perfection is not all that close. There is the little matter of *resolution*. Even the optimally-sensitive system wouldn't be of much use and certainly wouldn't be considered to be approaching perfection if it bit off great hunks of the image at a time and treated them as point-sources. One won't really be satisfied with image intensifiers until they can faithfully transmit an image of the diffraction pattern laid down on the photocathode by the best obtainable optics. One won't really be satisfied until the background haze due to thermal photoelectrons is eliminated, and even more important, until the available area of photocathode is increased a hundredfold over the present one square inch.

It's not just how many photoelectrons one can get recorded, but also how many different points in the image can be distinguished, because it is the *combination* of sensitivity and total number of image elements that determines how long one will have to freeze in the dome to obtain the greatest possible amount of information about the sky. If one wanted to survey the whole sky using a one-square-degree field and 10-minute exposures, he would need a total exposure time of 420,000 minutes, or 7,000 hours. If he had an image tube with the same number of distinguishable sensitive elements per area, but ten times the diameter, he

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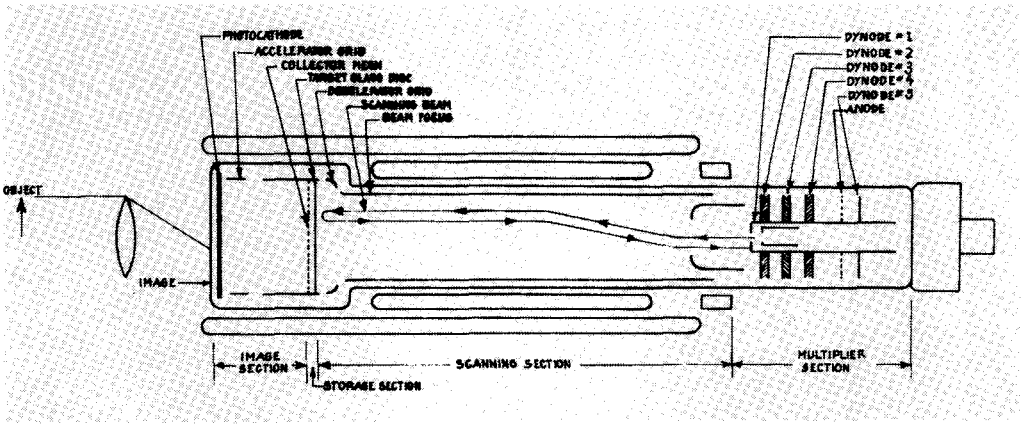

Schematic drawing of standard image orthicon television tube.

would need only 70 hours of exposure. One month, instead of eight years, allowing 30% usable weather.

Even with large size—98% efficiency—and infinitesimal fibers, there are some things one cannot do with an image intensifier using photographic film as the final recording device. Ultimately, one must look for a finer-grained way of recording than any practical emulsion can afford; photographic film is just too lumpy. We need a way to spread out the final image, without sacrificing any sensitivity, so as to make sure that our final record of image elements involves no overlap. We can't do this by optically spreading out the image onto film, because of the loss in film efficiency at very low light levels. As of now, it seems that the only answer is to spread the image out in the only other dimension we have under control, *time*.

We are now leaving the image intensifiers, which receive an image and immediately produce an image on a phosphor or on film, and entering the domain of scanning-type devices. A scanning device, in its simplest form, is nothing more than a photoelectric cell behind a tiny hole, which is moved in a regular pattern that eventually covers the image from the lens. As the cell scans back and forth, it delivers an electrical signal which stands for the intensity of light at each point as it is scanned. To turn this signal back into a picture, all we need to do is connect it to a light source that is moving in exactly the same pattern as the scanning aperture; the signal makes the light get brighter and dimmer as the photocell sees brighter and dimmer elements of the picture, so the original image is reproduced. Early

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attempts at television used schemes exactly like this, the photocell being apparently juggled madly back and forth and up and down by use of mirrors, and a spot of light controlled by the photocell being scanned across a screen in synchronism. I remember a picture showing one of the first test patterns transmitted—it was our familiar four-fingered rodent friend (I think he still had five fingers then), thus making the Mickey Mouse Club the oldest show on television by a comfortable margin.

Modern television works in essentially the same way: now instead of using mechanically-driven mirrors to let the photocell see each point of an image in turn, an all-electronic scanning system is used, in which an electron beam reads the image intensity of each point as it scans by; instead of wiggling a light bulb around with mirrors, we use the glowing spot on a phosphor screen as our movable light source—the intensity being controlled by means of throttling the electron beam that is making the spot. The idea, however, is basically unchanged.

The mechanism of the picture tube is relatively simple, involving an electron beam focused onto the back of a phosphor screen, and moved by means of variable magnetic fields synchronized with those in the transmitting camera miles away. What we are really interested in here, however, is the device which provides the intensity-signal—the camera tube in which an electron beam is made to sense the intensity of a point on an image. This isn't as simple as it appears, since electron beams are not sensitive to light.

Since we are talking about devices which are useful for looking at practically invisible objects, I won't go into the older scanning-type TV camera tubes, such as the iconoscope. Nor will I treat the vidicon, despite the fact that vidicons are getting more sensitive all the time and are small, simple, reliable, and inexpensive. By this time we all know that nothing small, simple, reliable, and inexpensive could be useful in astronomy—nature evidently finds astronomers offensive, and lets its annoyance be known in a multitude of subtle ways. Anyhow, vidicons are still some hundreds of times less sensitive than the first-place contender, the image orthicon. Before we discuss this specific device, however, we need a little general background to help us understand why this awkward and unpleasant device is the way it is.

When an image is faint enough, the electrons generated by a sensitive photocathode will *not*, at any one instant, represent the intensity of the light at each point of the image. This follows because of the statistical, sporadic nature of photoemission. One must take some kind of average of the rate at which photoelectrons leave every point of the sensitive surface before he can re-

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construct the original light image, and clearly the longer the averaging period, the more accurately will the gradations of intensity in the original be rendered. We would need to take these averages even if somehow we could manually count all electrons just after they were emitted, if we wanted a faithful picture. Therefore any imaging device that employs a photoemitting surface will have to contain some means for *storing* the photoelectrons, for storing them *all,* and for storing them in the right place, so that the original light image is preserved point-for-point. When enough electrons have been stored at the point corresponding to the weakest light in the picture, so that the statistical variations can be ignored, then and only then does it make sense to count them for the purpose of reconstructing an image. We, therefore, need what has come to be called a "target," a surface on which photoelectrons can be collected in an additive manner, and which corresponds point-for-point with the photocathode.

The image orthicon is divided into two main sections, the image section and the scanning section. The image section consists of the photocathode and a target, with both electrodes and magnetic fields which see to it that an electron leaving the photocathode at one point will reach only one predetermined point on the target. The scanning section is the part used for counting the stored charges once enough have been collected, but we'll get to that later.

The main properties a target must have are directly related to the necessity for capturing and holding electrical charge in one place. Electrons must find lateral travel—in the plane of the target—exceedingly difficult, and travel from one face of the target to the other very easy—so that charge can be removed when one is tired of it. These requirements have been satisfied, to varying degrees, in the image orthicon by targets made of very thin glass disks, or similar disks made of magnesium oxide or aluminum oxide. The magnesium oxide targets are made of crystals of MgO, and are somewhere around 700 angstroms thick: a stack of a million such targets would be about two and a half inches thick. The targets are about one inch in diameter, and are edge supported in a metal ring. I have been told that when a target is accidentally dropped while being mounted on its ring, it will float around the laboratory for days, in the air. Despite their incredible dimensions, the targets are quite strong, and image orthicons have been built which will take 10-G shocks or worse.

In the image section of an image orthicon we have a familiar picture: the photocathode over there, the target here, parallel to each other; photoelectrons are focused point-for-point from the cathode to the target, where they stick. This is another method for recording and ac-

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cumulating the emission of photoelectrons from a photocathode. Unfortunately for simplicity, there is still the problem of showing this picture to someone, because all we have is a pattern of charges on the target, a faithful but completely invisible version of the invisible image we are trying to look at.

As it happens, when the photoelectrons that are to be stored arrive at their proper addresses on the target, they do not simply alight and stick. They have been accelerated by an electric field, and when they hit, they not only don't stick, but they unstick a lot of other electrons —six or seven on the average. (More statistical noise—sorry about that.) This means that each electron contributes not a negative charge, but, by depriving the target of six or seven negative charges while adding at most one, it leaves a positively charged spot. The "electron image" is really a "positive-charge image," the intensity of positive charge representing the original light intensity at each point.

We have to work fast, now, if we want to work at room temperature. We have around ten seconds at best to get this positive-charge pattern read out before the hills and valleys of positive charge begin to leak sideways and merge into one another, at least if we are using MgO, which is one of the better materials.

Remember, we are now talking about a scanning device, meaning that we are going to convert the two-dimensional array of positive charges into a string of variations of electrical signals spaced out in *time*. This pretty well implies that we must proceed in a calm and orderly manner—during a time preferably short with respect to our total storage time of ten seconds—to examine every point of the one square inch of target, measure the amount of positive charge there, and adjust an electrical output to represent that amount.

Alas, we do not have time to look at every point, so let us settle for, say, half a million points. We shall move our scanning aperture along horizontal lines, looking at one row of charges after another, and we will make the aperture big enough so that half a million separate spots can be measured with no charge left unscanned between. The aperture size will thus be about 1.4 thousandths of an inch on a side, and we will use about 700 scanning lines.

The "aperture" that will be used will be the tip of a funny sort of beam of electrons, and now we are talking about the scanning section of an image orthicon.

At the base of an image orthicon, the end opposite the photocathode, is an electron gun with a tiny hole in its center. Electrons leaving this hole are encouraged to accelerate up toward the back surface of the target, by a nice attractive positive potential on an electrode, a metal cylinder wrapped around the vacuum

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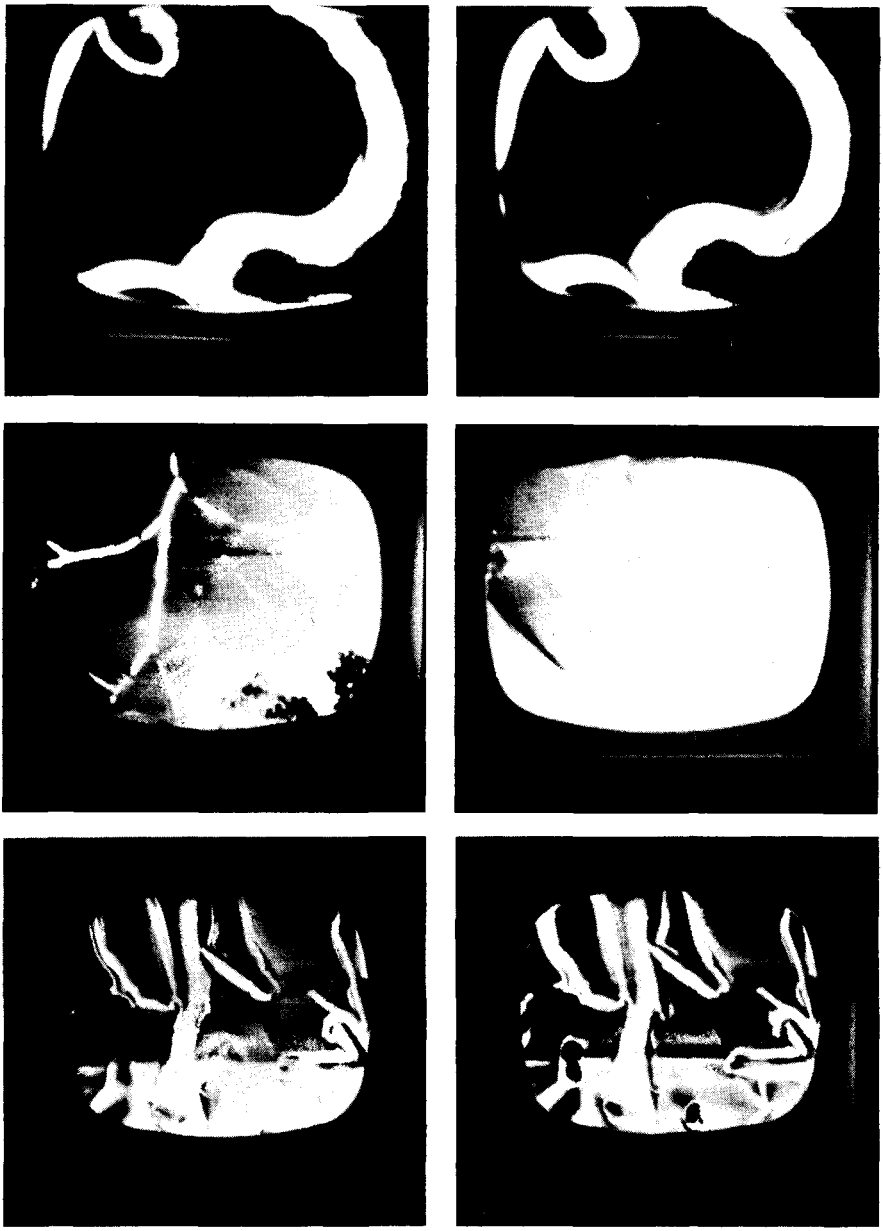

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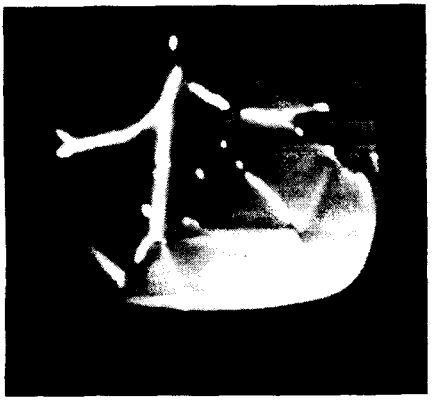

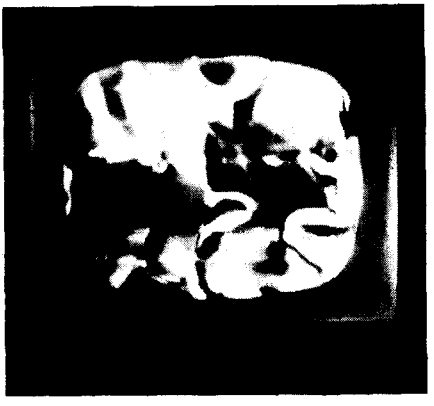

Death of an image orthicon tube,
as witnessed and photographed
at the monitor screen.
1 and 2: target overcharged,
contacts target mesh.
3-6: cracks in target appear.
7-9: SOB. 1800 bucks.

Lee Simon

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inside the neck of the tube. Just as the electrons see the target looming close and are preparing to slam into it, however, they encounter an electrical field from the target itself, which is exactly as discouraging as the original field was enticing. The electrons slow down, and just as they get to the target, or even slightly before, they stop. Since the repulsive field is still there, they turn around, accelerate away, regain their former peak velocity, and reenter the first accelerating field going backwards. They are, therefore, slowed down again, but since perfect symmetry is not preserved, they do *not* pop back into the little hole they came out of; most of them miss it and hit the flat metal plate the presence of which allows the hole to have real, as opposed to metaphysical, existence.

This metal plate is coated with cesium, and when the returning electrons strike it, they cause about three electrons to leave the plate. These secondary electrons are caught by an electrical field around the edge of the metal plate, and are accelerated toward the base of the tube, where they encounter—guess what—an electron multiplier structure. The return-beam shows up at the output of the electron multiplier about five hundred times huskier than it entered, and we have an output signal.

Oh, yes. How does it work? I have neglected to mention two things. First, the same magnetic field that focuses photoelectrons onto the target extends into the scanning section, where it focuses the electrons from the gun onto the target, as a tiny spot, 1.4 thousandths of an inch in diameter—not square, which would be nicer—or so. Also, there are some other magnetic fields which change rapidly, moving the place where this beam comes to a focus back and forth across the target, so that the beam is focused successively on every part of the surface of the target.

Who's that screaming: "But what makes it *work?*" Oh, yes, one more thing. The charge on the target.

Remember that the electrons are not only brought to a focus just as they reach the target—they also stop and turn back, to be collected and multiplied and ejected out a base pin as the output current. If we imagine that we are looking at a single star, then on the whole target there will be just one spot where the target is charged positive—all the rest will be neutral. The electron beam will start at the upper left-hand corner, scan to the right, snap back and scan the next line, snap back and so forth, and all the while a steady output current will be detected. When the scanning beam crosses the one positively-charged spot, however, enough electrons will be attracted out of the scanning beam to neutralize the charged spot—and there will be a brief dip in the output current. Then nothing more for the rest of the scan lines.

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Crater Bullialdus. Left, photo with Organ Mountain Station TV system on 12-inch telescope. Right, conventional photograph, 60-inch telescope. Organ Mountain Station is run by J. Dunlap, and is southwest operation of Dearborn Observatory. Now supplanted by Corralitos Observatory, under Dunlap. 24-inch telescope plus TV.

J. Dunlap

Over here, now, is an oscilloscope. We have arranged to scan its beam back and forth in exactly the same pattern as the beam in the image orthicon, starting at the upper left and scanning right, snapping back to start another line just at the right time. Furthermore, we have built an amplifier that converts a *drop* in output signal from the image orthicon into an *increase* in electron-beam current in the oscilloscope. We set the oscilloscope beam to a level where we just fail to see an illuminated spot, and start to scan our image of a star.

We start as before, scanning along with nothing happening. One line, two lines, and so on until we come to the line where the star image is waiting. The beam in the image orthicon scans across the positive spot, the output current dips briefly, the electron beam in the oscilloscope increases briefly, and then nothing more. But we have left a little bright spot, for a moment, on the screen of the oscilloscope, right where the image of the star is. May we call that a picture of the star?

A brighter star, of course, would

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cause more of a dip in output current, which in turn would cause more of an increase in oscilloscope beam current and a brighter spot on the screen. And if we had an image of, for example, a baseball diamond on the photocathode, then every portion of the target would carry a different charge, and the return beam would fluctuate wildly as the steady scan proceeded, and so would the intensity of the oscilloscope's electron beam, and there we have it—a picture.

In an ordinary broadcast TV camera, the scanning beam is continually repeating its scan pattern, completing each one in about 1/30 second, which is nothing to an astronomer.

In order to convert an ordinary broadcast TV camera to an astronomical camera of the simplest type, we must lengthen the available exposure time. Playing around with scanning speeds requires a lot of engineering, so the simplest way is to let the scan go on—that is, let the varying magnetic fields which move the focused beam around keep on varying—but turn off the electron gun that supplies the scanning electrons. The photoelectrons will then cause positive charges to accumulate on the target as long as the scanning beam is off, up to the time-limits set by sideways leakage of charge, which smears out the image. When a few seconds have passed, the electron beam can then be turned on just as the scanning magnetic fields are about to start a new frame, so that the target is scanned just once, wiping it more or less—mostly less—clean and preparing the way for the next exposure. Instead of having a picture presented thirty times per second on the output oscilloscope—the "monitor"—we now have a picture for just 1/30 of a second with a space between pictures up to ten seconds or so. We also have a most astonishingly sensitive astronomical sensor.

An experience which no astronomer could ever forget is seeing for the first time the image of a star cluster like M-13—The Great Cluster in Hercules—leap out on the screen after a 10-second exposure, the center burned out by the fury of 10,000 suns, and the rest of the screen filled with thousands of brilliant specks—this, mind you, with a 12-inch telescope! In the clear skies of New Mexico, we can see stars to about 14.5 magnitude at 30 frames per second, with this 1-foot aperture, working at f/15. If we pause as long as one second between readouts, we can just barely reach 17th magnitude. If a piece of the best available film were substituted for the faceplate of the image orthicon, we would have to expose about 200 times as long to reach the same limit of faintness.

Don't sell your Kodak stock, though—I am talking about sheer sensitivity, not information-gathering capability. The image orthicon

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loses a lot of its lead as soon as one recalls that on a given area, high-sensitivity film can record about four times as many separate dots, and that while the photocathode of the image orthicon is only 1.5 inches in diameter, one can buy photographic film in sizes having hundreds of times this area. For recording as many stellar images over as large an area of the sky as possible in the minimum possible time, photographic film still comes out ahead.

The situation changes radically, though, if the total available exposure time is short—say, a minute or so, as during an eclipse. If one is trying to detect the presence of something very faint, and exposure time cannot be stretched out to give film a fighting chance, and if total angular coverage of the sky is not important, then we are back to the figure of 200 or so in favor of the image orthicon. That is the reason for image orthicons being used in military sky-surveillance equipment: an unexpected satellite moving in an unpredictable direction through the field produces an image that moves across the sensor—the available exposure time is just the time it takes this image to move its own diameter, which can be extremely short, a few milliseconds. A system design using photographic film under optimum conditions—special telescope, et cetera—misses the performance of the image orthicon by a factor of at least 100.

I don't want to get into the involved business of optimum system design here, since this article is about the gadgets more than about how they are used. It would have been misleading, however, just to quote relative sensitivity figures without at least some mention of the application, because the usefulness both of film and of image orthicons, and their relative merits, depend very much on the purpose to which they are put.

Image orthicons operate pretty far below the theoretical limits set by the statistics of photoemission at the photocathode, at best a factor of ten below it. The principal reason for this is the way information is taken off the target once it has been stored there. The signal representing a star image appears as a slight *dip* in the return-beam current; this means that the "beam noise," caused by the fact that the scanning beam consists of individual electrons whose number varies randomly, remains constant as the signal shrinks; instead of the normal decrease of noise as the square root of the signal level, we have constant noise and a heart-rending worsening of signal-to-noise ratio for faint images. We know that the information is there, but the readout electron beam makes such an infernal electrical racket that we have to give up a good part of it.

One obvious way to get better overall efficiency is to make the image section, which produces the

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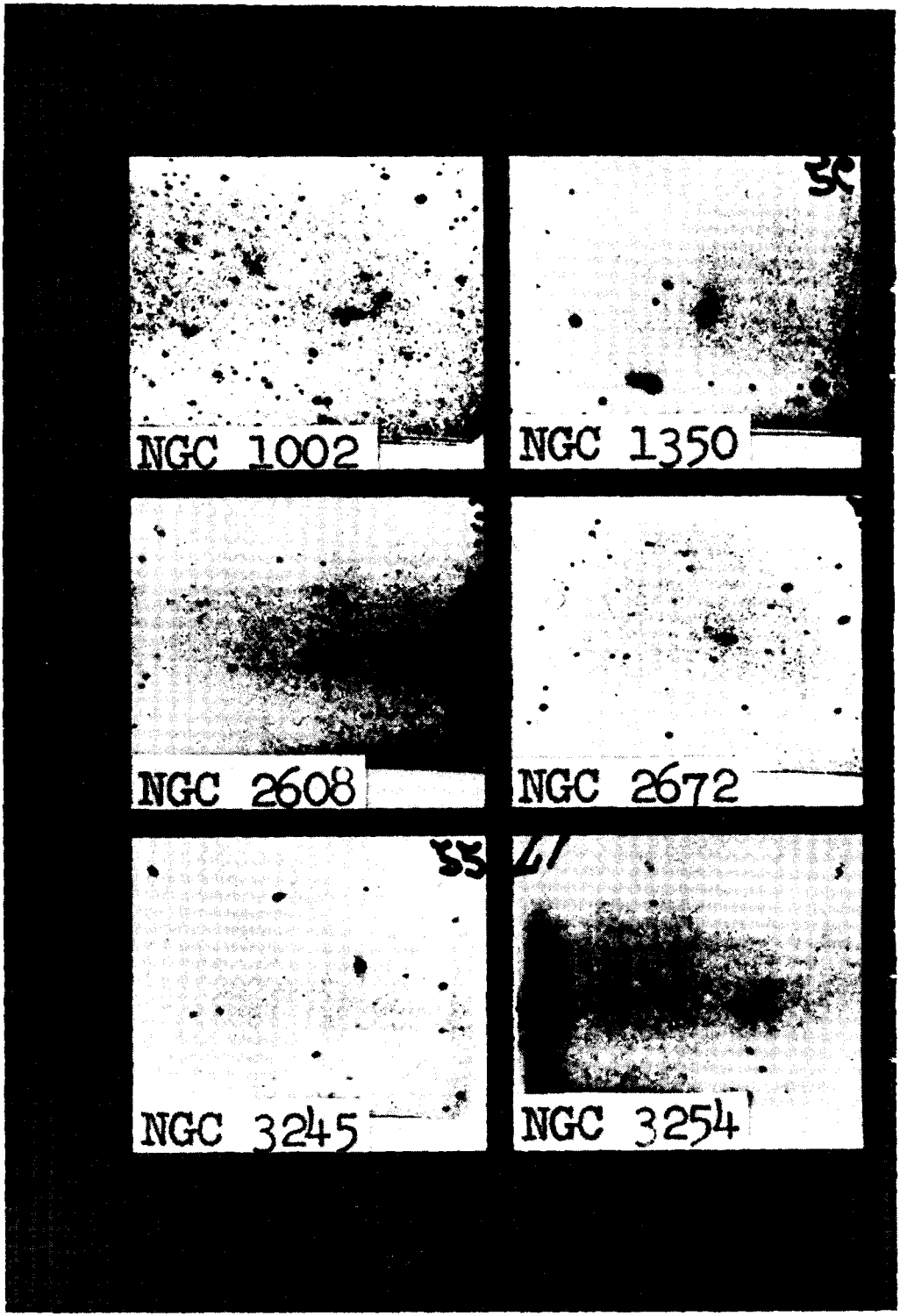

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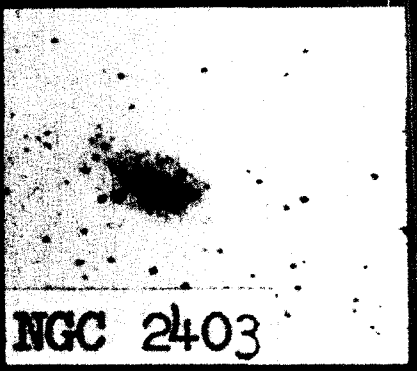
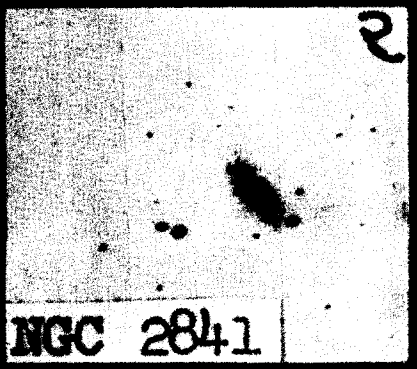
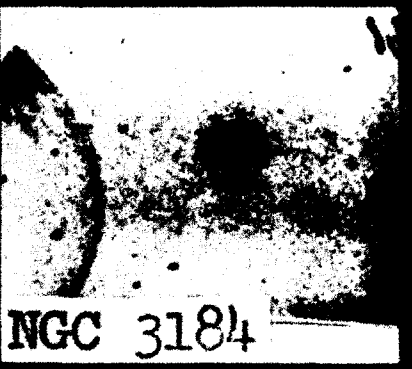
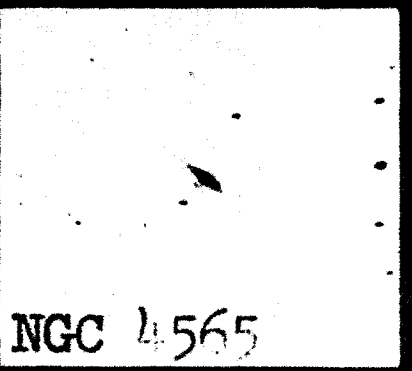






Galaxies photographed with Organ Mountain 12" telescope and TV equipment. Exposures around 8 to 16 seconds. All astronomical photos are photographs of monitor screen.



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stored charges, more efficient. We can't do this directly, because we are already getting as much out of the photocathode as presently possible. The only way that remains to help matters is to make each photoelectron that we do get cause more positive charge to appear on the target.

One way to do this is to use a different target material, one that has a very loose hold on its electrons so that instead of each photoelectron knocking out five or six electrons, it knocks loose fifty or sixty. We will then get bigger signals from the same images, and beam noise will, in comparison, be smaller. Such a material exists—it is formed by collecting potassium chloride smoke on a target, which is used only to hold the smoke now. The loose fibrous material has a very large surface area in comparison with its volume, so electrons have less distance to travel to escape the material. Unfortunately this material requires high-energy electrons to produce the large multiplication ratios that are possible, up to 10 kilovolts of acceleration being needed, so one has to deal with high voltages and all their attendant problems. Nonetheless, potassium chloride targets do promise some very sensitive devices when all the problems have been licked.

Another way to increase the positive charge generated by each photoelectron is to put an image intensifier, like the ones we have been talking about previously, in front of the image orthicon. We take the first photoelectrons, accelerate them through 10 or 20 kilovolts (high voltage again—the extra energy has to come from somewhere!) and let them alight on a phosphor screen. This time, however, the phosphor screen is mounted on a fiber-optics sheet, which soaks up about 40% of the emitted light and channels it to a transparent—semitransparent, of course—photocathode just a millimeter away on the other side of the fiber-optic disk. This second photocathode is the photocathode of the image section of the image orthicon, and the whole arrangement is sealed into an extended image-section envelope. Actually, while this would be the ideal setup, practical devices to date have used a thin sheet of mica instead of the fiber-optic disk, reliance being placed on getting the phosphor very close to the second photocathode as a means of keeping the light from spreading out and blurring the image. It blurs anyway.

These "intensifier orthicons" are, as advertised, exceedingly sensitive. One can see individual photoelectrons—and individual thermal electrons, and individual electrons pulled out of the photocathode by the initial 10,000 or 20,000 volts that is required there. If it weren't for this obnoxious background of unwanted electrons, which nobody has yet succeeded in eliminating, we

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could say that the intensifier orthicon is in fact operating at the limit set by the properties of the photocathode.

There's always a bug, which is what keeps engineers employed. In this case the bug is resolution. The newest and best intensifier orthicon that I know about has less than half the resolution of the straight image orthicon, which means that it can distinguish less than one-fourth the number of separate points—a lot of what is gained in sensitivity is thus canceled by loss of resolution, if information-gathering capacity is what one is concerned with. Half the resolution, however, is pretty close to equal, in the long run. I expect intensifier orthicons to improve greatly in the next few years, to the point that they may well supplant the image orthicon in astronomy.

There are many other devices that people are exploring—multiple-stage image tubes using either internal electron-to-light conversion, essentially stacks of simple intensifiers—or schemes in which the electron version of the light-image is slammed *through* as many as five membranes, picking up intensity at each one and yielding photon gains as high as 100,000—but very noisy, touchy on focus, and unreasonably demanding of high voltage. Completely solid-state devices exist, made in Japan, which will intensify an image that is brighter than some rather high threshold, and will show either the original image *or its negative!* A good deal of work is going on with "channel multipliers," consisting of little tubes packed together, each one lined with secondary-emitting material: photoelectrons enter the little tubes and crash back and forth from wall to wall as they pour through—multiplying many times on the way—giving an intensified electron image that can then be read out in all the ways we have seen so far. Channel multipliers are still pretty coarse, but progress is being made.

It's getting pretty hard to come up with a new idea for image conversion—the general term applying both to intensifiers and scanning-type devices—that someone isn't already working on. Looking over the whole field, it seems that the ideal device is just around the corner. What is it going to look like?

First. it's going to be much larger in diameter than present devices. (It will be round, because that's the way to use the largest possible area in a telescope focal plane that carries good images.) Something like five inches in diameter would seem reasonable.

Second. It will have a resolution capability of about 10 microns, so that the best possible images from a telescope will not be degraded perceptibly. In addition, the "grain" of the image will be smaller than 1 micron, so that a position measurement on the center of an image

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will have as much meaning as possible. This means that the tube will resolve about 125,000 scan lines.

Third. It will have a "quantum efficiency" of about 20% to 25%; one fifth to one fourth of the incoming photons will be recorded at the final output.

Fourth. It will be a signal-generating system, which means a scanning-type system, so that a final recording on magnetic tape may be employed; photographic film will *not* be used as a necessary step in access to the image information.

Fifth. It will employ extremely high magnetic focusing fields—10,000 gauss or more, created by superconducting electromagnets. Since you can't bend an electron beam in such a strong field, scanning will be done by a flying spot of light on a second photocathode, creating an electron beam where it is required at the moment. The superconducting magnet brings the diameter up to perhaps 12 inches.

Sixth. It will employ either membrane multiplication of photoelectrons or fiber-optic phosphor-photocathode sandwiches to assure that each photoelectron is recorded; the gain required here is about 100, so voltages need not be very high. The high magnetic fields will prevent spreading of the image from stage to stage, if electron-multiplication is used, which is likely.

Seventh. It will employ a target material of potassium chloride or something equivalent, so that lateral leakage will be extremely low at room temperature; an exposure of eight hours will be possible, with no loss in resolution.

Eighth. (Here I am proposing something which we can't build yet, but which will be possible when its usefulness is realized.) The target will be "leaky" in the sense that the stored charge will slowly leak away at a rate proportional to the amount of charge that is present—but *without lateral spreading*.What this does is to make the response proportional to the *logarithm* of light-intensity. At first glance it might appear foolish to throw away any charge, but consider the following: In an exposure of eight hours—from a 12-inch telescope on the moon, of course, where skylight is not so much of a problem—one could theoretically see stars—or rather, galaxies—of around 30th magnitude with an 8-hour exposure during the lunar night. Any field of view, however, is almost sure to contain a few stars of 15th magnitude—still 4,000 times too faint to see. These stars would be 1,000,000 times brighter than the faintest ones in the same field, and I am not optimistic about our ever being able to read out satisfactorily such a range of electrical charges, with a single setup of the system. We need a nice nonlinear target; ergo, we shall have one some day.

Ninth. The electronics that go with this system will be rather interesting: About ten trillion points will

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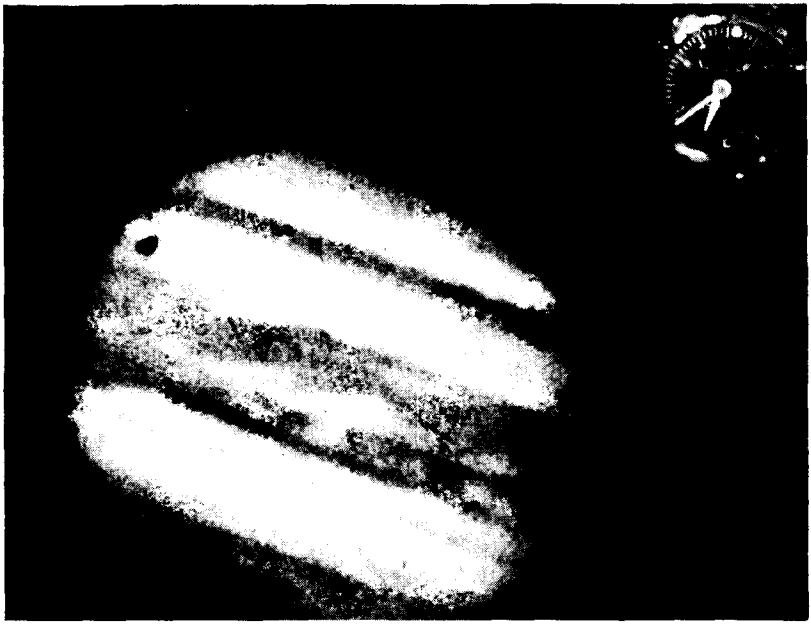
have to be read out in some reasonable time, which means that a readout frame will take 100 seconds with a bandwidth in the video system of 35 megacycles, or 10 seconds with a bandwidth running from D.C. to 350 megacycles (!). I would guess that what comes out of the tube will be not the signal itself, but a modulated RF signal at about 1,000 megacycles—therefore, the back of this 12-inch diameter, 2-foot-long device will have a waveguide, not a coaxial cable, coming out its rear end to carry the signal.

Tenth. This device will be exasperatingly expensive, prone to a whole new and exciting list of malfunctions, too heavy for one man to put onto the telescope, subject to interference from phenomena thought previously to affect only the flavor of pizza; or, to put it briefly, the kind of gadget that brings tender smiles of understanding to the faces of electronikers and deepens the lines around the eyes of long-suffering, but unbelievably dogged, astronomers. ■

Jupiter and satellite Io, showing satellite shadow. 12-inch telescope and TV system, 30 frames per second. Eyepiece projection used to bring image to full diameter of TV screen. Spectacular to see.



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The Featherbedders

There are circumstances under which the Invading Aliens really wouldn't want to change Earth's culture very much . . . just use it . . .

FRANK HERBERT

Illustrated by Leo Summers

"Once there was a Slorin with a one-syllable name who is believed to have said: ' niche for every one of us and every one of us in his niche.' "

—Folk saying of the *Scattership* People

There must be a streak of madness in a Slorin who'd bring his only offspring, an untrained and untried youth, on a mission as potentially dangerous as this one, Smeg told himself.

The rationale behind his decision remained clear: The colonial nucleus must preserve its elders for their detail memory. The youngest of the group was the logical one to be volunteered for this risk. Still . . .

Smeg forced such thoughts out of his mind. They weakened him. He concentrated on driving the gray motor-pool Plymouth they'd signed out of the government garage in the state capital that morning. The machine demanded considerable attention.

The Plymouth was only two years old, but this region's red rock roads and potholes had multiplied those years by a factor of at least four. The steering was loose and assorted squeaks arose from front and rear as he negotiated a rutted downgrade. The road took them into a shadowed gulch almost bare of vegetation and across the rattling planks of a wooden bridge that spanned a dry creekbed. They climbed out the other side through ancient erosion gullies, past a zone of scrub cottonwoods and onto the reaching flat land they'd been crossing for two hours.

Smeg risked a glance at Rick, his offspring, riding silently beside him. The youth had come out of the pupal stage with a passable human shape. No doubt Rick would do better next time—provided he had the opportunity. But he was well within the seventy-five percent accuracy limit the Slorin set for themselves. It was a universal fact that the untrained sentience saw what it *thought* it saw. The mind tended to supply the missing elements.

A nudge from the Slorin mind-

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cloud helped, of course, but this carried its own perils. The nudged mind sometimes developed powers of its own—with terrifying results. Slorin had learned long ago to depend on the directional broadcast of the mind's narrow band, and to locate themselves in a network limited by the band's rather short range.

However, Rick had missed none of the essentials for human appearance. He had a gentle, slender face whose contours were difficult to remember. His brown eyes were of a limpid softness that made human females discard all suspicions while the males concentrated on jealousy. Rick's hair was a coarse, but acceptable black. The shoulders were a bit high and the thorax somewhat too heroic, but the total effect aroused no probing questions.

That was the important thing: no probing questions.

Smeg permitted himself a silent

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sigh. His own shape—that of a middle-aged government official, gray at the temples, slightly paunchy and bent of shoulder, and with weak eyes behind gold-rimmed glasses—was more in the Slorin tradition.

Live on the margins, Smeg thought. *Attract no attention.*

In other words, don't do what they were doing today.

Awareness of danger forced Smeg into extreme contact with this body his plastic genes had fashioned. It was a good body, a close enough duplicate to interbreed with the natives, but he felt it now from the inside, as it were, a fabric of newness stretched over the ancient substance of the Slorin. It was familiar, yet bothersomely unfamiliar.

I am Sumctroxelunsmeg, he reminded himself. *I am a Slorin of seven syllables, each addition to my name an honor to my family. By the pupa of my jelly-sire whose name took fourteen thousand heartbeats to pronounce, I shall not fail!*

There! That was the spirit he needed—the eternal wanderer, temporarily disciplined, yet without boundaries. "If you want to swim, you must enter the water," he whispered.

"Did you say something, Dad?" Rick asked.

Ahhh, that was very good, Smeg thought. Dad—the easy colloquialism.

"I was girding myself for the ordeal, so to speak," Smeg said. "We must separate in a few minutes." He nodded ahead to where a town was beginning to hump itself out of the horizon.

"I think I should barge right in and start asking about their sheriff," Rick said.

Smeg drew in a sharp breath, a gesture of surprise that fitted this body. "Feel out the situation first," he said.

More and more, he began to question the wisdom of sending Rick in there. Dangerous, damnably dangerous. Rick could get himself irrevocably killed, ruined beyond the pupa's powers to restore. Worse than that, he could be exposed. There was the real danger. Give natives the knowledge of what they were fighting and they tended to develop extremely effective methods.

Slorin memory carried a bagful of horror stories to verify this fact.

"The Slorin must remain ready to take any shape, adapt to any situation," Rick said. "That it?"

Rick spoke the axiom well, Smeg thought, but did he really understand it? How could he? Rick still didn't have full control of the behavior patterns that went with this particular body shape. Again, Smeg sighed. If only they'd saved the infiltration squad, the expendable specialists.

Thoughts such as this always brought the more disquieting question: *Saved them from what?*

There had been five hundred pupae in the *Scattership* before the

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unknown disaster. Now, there were four secondary ancestors and one new offspring created on this planet. They were shipless castaways on an unregistered world, not knowing even the nature of the disaster which had sent them scooting across the void in an escape capsule with minimum shielding.

Four of them had emerged from the capsule as basic Slorin polymorphs to find themselves in darkness on a steep landscape of rocks and trees. At morning, there'd been four additional trees there—watching, listening, weighing the newness against memories accumulated across a timespan in which billions of planets such as this one could have developed and died.

The capsule had chosen an excellent landing site: no nearby sentient constructions. The Slorin now knew the region's native label—central British Columbia. In that period of awakening, though, it had been a place of unknown dangers whose chemistry and organization required the most cautious testing.

In time, four black bears had shambled down out of the mountains. Aproaching civilization, they'd hidden and watched—listening, always listening, never daring to use the mindcloud. Who knew what mental powers the natives might have? Four roughly fashioned hunters had been metamorphosed from Slorin pupae in a brush-screened cave. The hunters had been tested, refined.

Finally—the hunters had scattered.

Slorin always scattered.

"When we left Washington you said something about the possibility of a trap," Rick said. "You don't really think—"

"Slorin have been unmasked on some worlds," Smeg said. "Natives have developed situational protective devices. This has some of the characteristics of such a trap."

"Then why investigate? Why not leave it alone until we're stronger?"

"Rick!" Smeg shuddered at the youth's massive ignorance. "Other capsules may have escaped," he said.

"But if it's a Slorin down here, he's acting like a dangerous fool."

"More reason to investigate. We could have a damaged pupa here, one who lost part of the detail memory. Perhaps he doesn't know how to act—except out of instincts."

"Then why not stay out of the town and probe just a little bit with the mindcloud?"

Rick cannot be trusted with this job, Smeg thought. *He's too raw, too full of the youthful desire to play with the mindcloud.*

"Why not?" Rick repeated.

Smeg pulled the car to a stop at the side of the dirt road, opened his window. It was getting hot—be noon in about an hour. The landscape was a hardscrabble flatness marked by sparse vegetation and a clump of buildings about two miles ahead. Broken fences lined both

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sides of the road. Low cottonwoods off to the right betrayed the presence of the dry creekbed. Two scrofulous oaks in the middle distance provided shade for several steers. Away on the rim of the batland, obscured by haze, there was a suggestion of hills.

"You going to try my suggestion?" Rick asked.

"No."

"Then why're we stopping? This as far as you go?"

"No." Smeg sighed. "This is as far as *you* go. I'm changing plans. You will wait. I will go into the village."

"But I'm the younger. I'm—"

"And I'm in command here."

"The others won't like this. They said—"

"The others will understand my decision."

"But Slorin law says—"

"Don't quote Slorin law to me!"

"But—"

"Would you teach your grandfather how to shape a pupa?" Smeg shook his head. Rick must learn how to control the anger which flared in this bodily creation. "The limit of the law is the limit of enforcement—the real limit of organized society. We're not an organized society. We're two Slorin—alone, cut off from our pitiful net. Alone! Two Slorin of widely disparate ability. You are capable of carrying a message. I do not judge you capable of meeting the challenge in this village."

Smeg reached across Rick, opened the door.

"*This is a firm decision?*" Rick asked.

"It is. You know what to do?"

Rick spoke stiffly: "I take that kit of yours from the back and I play the part of a soil engineer from the Department of Agriculture."

"Not a *part*, Rick. You *are* a soil engineer."

"But—"

"You will make real tests which will go into a real report and be sent to a real office with a real function. In the event of disaster, you will assume my shape and step into my niche."

"I see."

"I truly hope you do. Meanwhile, you will go out across that field. The dry creekbed is out there. See those cottonwoods?"

"I've identified the characteristics of this landscape."

"Excellent. Don't deviate. Remember that you're the offspring of Sumctroxelunsmeg. Your jelly-sire's name took fourteen thousand heartbeats to pronounce. Live with pride."

"I was supposed to go in there, take the risk of it—"

"There are risks and there are risks. Remember, make real tests for a real report. Never betray your niche. When you have made the tests, find a place in that creekbed to secrete yourself. Dig in and wait. Listen on the narrow band at all times. Listen, that is all you do. In

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the event of disaster, you must get word to the others. In the kit there's a dog collar with a tag bearing a promise of reward and the address of our Chicago drop. Do you know the greyhound shape?"

"I know the plan, Dad."

Rick slid out of the car. He removed a heavy black case from the rear, closed the doors, stared in at his parent.

Smeg leaned across the seat, opened the window. It creaked dismally.

"Good luck, Dad," Rick said.

Smeg swallowed. This body carried a burden of attachment to an offspring much stronger than any in previous Slorin experience. He wondered how the offspring felt about the parent, tried to probe his own feelings toward the one who'd created him, trained him, sealed his pupa into the *Scattership*. There was no sense of loss. In some ways, he *was* the parent. As different: experiences changed him, he would become more and more the individual, however. Syllables would be added to his name. Perhaps, someday, he might feel an urge to be reunited.

"Don't lose your cool, Dad," Rick said.

"The God of the Slorin has no shape," Smeg said. He closed the window, straightened himself behind the steering wheel.

Rick turned, trudged off across the field toward the cottonwoods. A low cloud of dust marked his progress. He carried the black case easily in his right hand.

Smeg put the car in motion, concentrated on driving. That last glimpse of Rick, sturdy and obedient, had pierced him with unexpected emotions. Slorin parted, he told himself. It is natural for Slorin to part. An offspring is merely an offspring.

A Slorin prayer came into his mind: "Lord, let me possess this moment without regrets and, losing it, gain it forever."

The prayer helped, but Smeg still felt the tug of that parting. He stared at the shabby buildings of his target town. Someone in this collection of structures Smeg was now entering had not learned a basic Slorin lesson: *There is a reason for living; Slorin must not live in a way that destroys this reason.*

Moderation, that was the key.

A man stood in the dusty sunglare toward the center of the town —one lone man beside the dirt road that ran unchecked toward the distant horizon. For one haunted moment Smeg had the feeling it was not a man, but a dangerous other-shaped enemy he'd met before. The feeling passed as Smeg brought the car to a stop nearby.

Here was the American peasant, Smeg realized—tall, lean, dressed in wash-faded blue bib overalls, a dirty tan shirt and tennis shoes. The shoes were coming apart to reveal bare toes. A ground green painter's hat

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with green plastic visor did an ineffective job of covering his yellow hair. The visor's rim was cracked. It dripped a fringe of ragged binding that swayed when the man moved his head.

Smeg leaned out his window, smiled: "Howdy."

"How do."

Smeg's sense of hearing, trained in a history of billions of such encounters, detected the xenophobia and reluctant bowing to convention at war in the man's voice.

"Town's pretty quiet," Smeg said.

"Yep."

Purely human accents, Smeg decided. He permitted himself to relax somewhat, asked: "Anything unusual ever happen around here?"

"You fum the gov'ment?"

"That's right." Smeg tapped the motor-pool insignia on his door. "Department of Agriculture."

"Then you ain't part of the gov'ment conspiracy?"

"Conspiracy?" Smeg studied the man for a clue to hidden meanings. Was this one of those southern towns where anything from the government just had to be communist?

"Guess you ain't," the man said.

"Of course not."

"That there was a serious question you asked, then . . . about unusual thing happening?"

"I . . . yes."

"Depends on what you call unusual."

"What . . . do *you* call unusual?" Smeg ventured.

"Can't rightly say. And you?"

Smeg frowned, leaned out his window, looked up and down the street, studied each detail: the dog sniffing under the porch of a building labeled "General Store," the watchful blankness of windows with here and there a twitching curtain to betray someone peering out, the missing boards on the side of a gas station beyond the store—one rusty pump there with its glass chamber empty. Every aspect of the town spoke of heat-addled somnolence . . . yet it was wrong. Smeg could feel tensions, transient emotional eddies that irritated his highly tuned senses. He hoped Rick already had a hiding place and was listening.

"This is Wadeville, isn't it?" Smeg asked.

"Yep. Used to be county seat 'fore the war."

He meant the War Between The States, Smeg realized, recalling his studies of regional history. As always, the Slorin were using every spare moment to absorb history, mythology, arts, literature, science —You never knew which might be the valuable piece of information.

"Ever hear about someone could get right into your mind?" the man asked.

Smeg overcame a shock reaction, groped for the proper response. Amused disbelief, he decided, and managed a small chuckle. "That the unusual thing you have around here?"

"Didn't say yes; didn't say no."

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"Why'd you ask then?" Smeg knew his voice sounded like crinkling bread wrapper. He pulled his head back into the car's shadows.

"I jes' wondered if you might be hunting fer a teleepath?"

The man turned, hawked a cud of tobacco toward the dirt at his left. A vagrant breeze caught the spittle, draped it across the side of Smeg's car.

"Oh, dang!" the man said. He produced a dirty yellow bandanna, knelt and scrubbed with it at the side of the car.

Smeg leaned out, studied this performance with an air of puzzlement. The man's responses, the vague hints at mental powers—they were confusing, fitted no pattern in Slorin experience.

"You got somebody around here claiming to be a telepath?" Smeg asked.

"Can't say." The man stood up, peered in at Smeg. "Sorry about that there. Wind, y' know. Accident. Didn't mean no harm."

"Certainly."

"Hope you won't say nothing to the sheriff. Got 'er all cleaned off your car now. Can't tell where I hit 'er."

The man's voice carried a definite tone of fear, Smeg realized. He stared at this American peasant with a narrow, searching gaze. *Sheriff,* he'd said. Was it going to be this easy? Smeg wondered how to capitalize on that opening. Sheriff. Here was an element of the mystery they'd come to investigate.

As the silence drew out, the man said: "Got 'er all clean. You can get out and look for yourself."

"I'm sure you did, Mr. . . . ahhh . . . "

"Painter, Josh'a Painter. Most folks call me Josh on account of my first name there, Josh'a Painter."

"Pleased to meet you, Mr. Painter. My name's Smeg, Henry Smeg."

"Smeg," Painter said with a musing tone. "Don't rightly believe I ever heard that name before."

"It used to be much longer," Smeg said. "Hungarian."

"Oh."

"I'm curious, Mr. Painter, why you'd be afraid I might tell the sheriff because the wind blew a little tobacco juice on my car?"

"Never can tell how some folks'll take things," Painter said. He looked from one end of Smeg's car to the other, back to Smeg. "You a gov'-ment man, this car an' all, reckoned I'd best be sure, one sensible man to another."

"You've been having trouble with the government around here, is that it?"

"Don't take kindly to most gov'-ment men hereabouts, we don't. But the sheriff, he don't allow us to do anything about that. Sheriff is a mean man, a certain mean man sometimes, and he's got my Barton."

"Your barton," Smeg said, drawing back into the car to conceal his

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puzzlement. *Barton?* This was an entirely new term. Strange that none of them had encountered it before. Their study of languages and dialects had been most thorough. Smeg began to feel uneasy about his entire conversation with this Painter. The conversation had never really been under control. He wondered how much of it he'd actually understood. There was in Smeg a longing to venture a mind-cloud probe, to nudge the man's motives, make him *want* to explain.

"You one of them survey fellows like we been getting?" Painter asked.

"You might say that," Smeg said. He straightened his shoulders. "I'd like to walk around and look at your town, Mr. Painter. May I leave my car here?"

" 'Tain't in the way that I can see," Painter said. He managed to appear both interested and disinterested in Smeg's question. His glance flicked sideways, all around—at the car, the road, at a house behind a privet hedge across the way.

"Fine," Smeg said. He got out, slammed the door, reached into the back for the flat-crowned western hat he affected in these parts. It tended to break down some barriers.

"You forgetting your papers?" Painter asked.

"Papers?" Smeg turned, looked at the man.

"Them papers full of questions you gov'ment people allus use."

"Oh." Smeg shook his head. "We can forget about papers today."

"You jes' going to wander around?" Painter asked.

"That's right."

"Well, some folks'll talk to you," Painter said. "Got all kinds of different folks here." He turned away, started to walk off.

"Please, just a minute," Smeg said.

Painter stopped as though he'd run into a barrier, spoke without turning. "You want something?"

"Where're you going, Mr. Painter?"

"Jes' down the road a piece."

"I'd . . . ahhh, hoped you might guide me," Smeg said. "That is if you haven't anything better to do?"

Painter turned, stared at him. "Guide? In Wadeville?" He looked around him, back to Smeg. A tiny smile tugged at his mouth.

"Well, where do I find your sheriff, for instance?" Smeg asked.

The smile disappeared. "Why'd you want him?"

"Sheriffs usually know a great deal about an area."

"You sure you actual' want to see him?"

"Sure. Where's his office?"

"Well now, Mr. Smeg. . . ." Painter hesitated, then: "His office is just around the corner here, next the bank."

"Would you show me?" Smeg moved forward, his feet kicking up dust puddles in the street. "Which corner?"

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"This'n right here." Painter pointed to a field stone building at his left. A weed-grown lane led off past it. The corner of a wooden porch jutted from the stone building into the lane.

Smeg walked past Painter, peered down the lane. Tufts of grass grew in the middle and along both sides, green runners stretching all through the area. Smeg doubted that a wheeled vehicle had been down this way in two years—possibly longer.

A row of objects on the porch caught his attention. He moved closer, studied them, turned back to Painter.

"What're all those bags and packages on that porch?"

"Them?" Painter came up beside Smeg, stood a moment, lips pursed, eyes focused beyond the porch.

"Well, what are they?" Smeg pressed.

"This here's the bank," Painter said. "Them's night deposits."

Smeg turned back to the porch. Night deposits? Paper bags and fabric sacks left out in the open?

"People leaves 'em here if'n the bank ain't open," Painter said. "Bank's a little late opening today. Sheriff had 'em in looking at the books last night."

Sheriff examining the bank's books? Smeg wondered. He hoped Rick was missing none of this and could repeat it accurately . . . just in case. The situation here appeared far more mysterious than the reports had indicated. Smeg didn't like the feeling of this place at all.

"Makes it convenient for people who got to get up early and them that collects their money at night," Painter explained.

"They just leave it right out in the open?" Smeg asked.

"Yep. 'Night deposit' it's called. People don't have to come around when—"

"I know what it's called! But . . . right out in the open like that . . . without a guard?"

"Bank don't open till ten thirty most days," Painter said. "Even later when the sheriff's had 'em in at night."

"There's a guard," Smeg said. "That's it, isn't it?"

"Guard? What we need a guard fer? Sheriff says leave them things alone, they gets left alone."

The sheriff again, Smeg thought. "Who . . . ahh, deposits money like this?" he asked.

"Like I said: the people who got to get up early and . . ."

"But *who* are these people?"

"Oh. Well, my cousin Reb: He has the gas station down to the forks. Mr. Seelway at the General Store there. Some farmers with cash crops come back late from the city. Folks work across the line at the mill in Anderson when they get paid late of a Friday. Folks like that."

"They just . . . leave their money out on this porch."

"Why not?"

"Lord knows," Smeg whispered.

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"Sheriff says don't touch it, why —it don't get touched."

Smeg looked around him, sensing the strangeness of this weed-grown street with its wide-open night depository protected only by a sheriff's command. Who was this sheriff? *What* was this sheriff?

"Doesn't seem like there'd be much money in Wadeville," Smeg said. "That gas station down the main street out there looks abandoned, looks like a good wind would blow it over. Most of the other buildings—"

"Station's closed," Painter said. "You need gas, just go out to the forks where my cousin, Reb—"

"Station failed?" Smeg asked.

"Kind of."

"Kind of?"

"Sheriff, he closed it."

"Why?"

"Fire hazard. Sheriff, he got to reading the state Fire Ordinance one day. Next day he told ol' Jamison to dig up the gas tanks and cart 'em away. They was too old and rusty, not deep enough in the ground and didn't have no concrete on 'em. 'Sides that, the building's too old, wood all oily."

"The sheriff ordered it . . . just like that." Smeg snapped his fingers.

"Yep. Said he had to tear down that station. Ol' Jamison sure was mad."

"But if the sheriff says do it, then it gets done?" Smeg asked.

"Yep. Jamison's tearing it down —one board every day. Sheriff don't seem to pay it no mind long as Jamison takes down that one board every day."

Smeg shook his head. One board every day. What did that signify? Lack of a strong time sense? He looked back at the night deposits on the porch, asked: "How long have people been depositing their money here this way?"

"Been since a week or so after the sheriff come."

"And how long has that been?"

"Ohhhhh . . . four, five years maybe."

Smeg nodded to himself. His little group of Slorin had been on the planet slightly more than five years. This could be . . . this could be— He frowned. But what if it wasn't?

The dull plodding of footsteps sounded from the main street behind Smeg. He turned, saw a tall fat man passing there. The man glanced curiously at Smeg, nodded to Painter.

"Mornin', Josh," the fat man said. It was a rumbling voice.

"Mornin', Jim," Painter said.

The fat man skirted the Plymouth, hesitated to read the emblem on the car door, glanced back at Painter, resumed his plodding course down the street and out of sight.

"That was Jim," Painter said.

"Neighbor?"

"Yep. Been over to the Widow McNabry's again . . . all the whole dang' night. Sheriff's going to

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be mighty displeasured believe me."

"He keeps an eye on your morals, too?"

"Morals?" Painter scratched the back of his neck. "Can't rightly say he does."

"Then why would he mind if . . . Jim—"

"Sheriff, he says it's a sin and a crime to take what don't belong to you, but it's a blessing to give. Jim, he stood right up to the sheriff, said he jes' went to the widow's to give. So—" Painter shrugged.

"The sheriff's open to persuasion, then?"

"Some folks seems to think so."

"You don't?"

"He made Jim stop smoking and drinking."

Smeg shook his head sharply, wondering if he'd heard correctly. The conversation kept darting around into seeming irrelevancies. He adjusted his hat brim, looked at his hand. It was a good hand, couldn't be told from the human original. "Smoking and drinking?" he asked.

"Yep."

"But why?"

"Said if Jim was taking on new ree-sponsibilities like the widow he couldn't commit suicide—not even slow like."

Smeg stared at Painter who appeared engrossed with a nonexistent point in the sky. Presently, Smeg managed: "That's the weirdest interpretation of the law I ever heard."

"Don't let the sheriff hear you say that."

"Quick to anger, eh?"

"Wouldn't say that."

"What *would* you say?"

"Like I told Jim: Sheriff get his eye on you, that is it. You going to toe the line. Ain't so bad till the sheriff get his eye on you. When he see you—that is the end."

"Does the sheriff have his eye on you, Mr. Painter?"

Painter made a fist, shook it at the air. His mouth drew back in a fierce, scowling grimace. The expression faded. Presently, he relaxed, sighed.

"Pretty bad, eh?" Smeg asked.

"Dang conspiracy," Painter muttered. "Gov'ment got its nose in things don't concern it."

"Oh?" Smeg watched Painter closely, sensing they were on productive ground. "What does—"

"Dang near a thousand gallons a year!" Painter exploded.

"Uhhh—" Smeg said. He wet his lips with his tongue, a gesture he'd found to denote human uncertainty.

"Don't care if you are part of the conspiracy," Painter said. "Can't do nothing to me now."

"Believe me, Mr. Painter, I have no designs on . . ."

"I made some 'shine when folks wanted," Painter said. "Less'n a thousand gallons a year . . . almost. Ain't much considering the size of some of them stills t'other side of Anderson. But them's across the line! 'Nother county! All I made

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was enough fer the folks 'round here."

"Sheriff put a stop to it?"

"Made me bust up my still."

"Made *you* bust up your still?"

"Yep. That's when he got my Barton."

"Your . . . ahhh . . . barton?" Smeg ventured.

"Right from under Lilly's nose," Painter muttered. His nostrils dilated, eyes glared. Rage lay close to the surface.

Smeg looked around him, searching the blank windows, the empty doorways. What in the name of all the Slorin furies was a barton?

"Your sheriff seems to hold pretty close to the law," Smeg ventured.

"Hah!"

"No liquor," Smeg said. "No smoking. He rough on speeders?"

"Speeders?" Painter turned his glare on Smeg. "Now, you tell me what we'd speed in, Mr. Smeg."

"Don't you have any cars here?"

"If my cousin Reb didn't have his station over to the forks where he get the city traffic, he'd be bust long ago. State got a law—car got to stop in jes' so many feet. Got to have jes' so many lights. Got to have windshield wiper things. Got to have tires which you can measure the tread on. Got to steer ab-solutely jes' right. Car don't do them things, it is *junk*. Junk! Sheriff, he make you sell that car for junk! Ain't but two, three folks in Wadeville can afford a car with all them things."

"He sounds pretty strict," Smeg said.

"Bible-totin' parson with hell fire in his eye couldn't be worse. I tell you, if that sheriff didn't have my Barton, I'd a run out long ago. I'd a ree-beled like we done in Sixty-one. Same with the rest of the folks here . . . most of 'em."

"He has their . . . ahhh, bartons?" Smeg asked, cocking his head to one side, waiting.

Painter considered this for a moment, then: "Well, now . . . in a manner of speaking, you could call it that way."

Smeg frowned. Did he dare ask what a barton was? No! It might betray too much ignorance. He longed for a proper Slorin net, all the interlocked detail memories, the Slorin spaced out within the limits of the narrow band, ready to relay questions, test hypotheses, offer suggestions. But he was alone except for one inexperienced offspring hiding out there across the fields . . . waiting for disaster. Perhaps Rick had encountered the word, though. Smeg ventured a weak interrogative.

Back came Rick's response, much too loud: "Negative."

So Rick didn't know the word either.

Smeg studied Painter for a sign the man had detected the narrow band exchange. Nothing. Smeg swallowed, a natural fear response he'd noticed in this body, decided to move ahead more strongly.

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"Anybody ever tell you you have a most unusual sheriff?" he asked.

"Them gov'ment survey fellows, that's what they say. Come here with all them papers and all them questions, say they interested in our crime rate. Got no crime in Wade County, they say. Think they telling us something!"

"That's what I heard about you," Smeg offered. "No crime."

"Hah!"

"But there must be some crime," Smeg said.

"Got no 'shine," Painter muttered. "Got no robbing and stealing, no gambling. Got no drunk drivers 'cepting they come from somewheres else and then they is mighty displeasured they drunk drove in Wade County. Got no *ju*-venile deelinquents like they talk about in the city. Got no patent medicine fellows. Got nothing."

"You must have a mighty full jail, though."

"Jail?"

"All the criminals your sheriff apprehends."

"Hah! Sheriff don't throw folks in jail, Mr. Smeg. Not 'less they is from over the line and needs to sleep off a little ol' spree while they sobers up enough to pay the fine."

"Oh?" Smeg stared out at the empty main street, remembering the fat man—Jim. "He gives the local residents a bit more latitude, eh? Like your friend, Jim."

"Jes' leading Jim along, I say."

"What do you mean?"

"Pretty soon the widow's going to be in the family way. Going to be a quick wedding and a baby and Jim'll be jes' like all the rest of us."

Smeg nodded as though he understood. It was like the reports which had lured him here . . . but unlike them, too. Painter's "survey fellows" had been amused by Wadeville and Wade County, so amused even their driest governmentese couldn't conceal it. Their amusement had written the area off —"purely a local phenomenon." Tough southern sheriff. Smeg was not amused. He walked slowly out to the main street, looked back along the road he'd traveled.

Rick was out there listening . . . waiting.

What would the waiting produce?

An abandoned building up the street caught Smeg's attention. Somewhere within it a door creaked with a rhythm that matched the breeze stirring the dust in the street. A "SALOON" sign dangled from the building on a broken guy wire. The sign swayed in the wind—now partly obscured by a porch roof, now revealed: "LOON" . . . "SALOON" . . . "LOON" . . . "SALOON" . . .

The mystery of Wadeville was like that sign, Smeg thought. The mystery moved and changed, now one thing, now another. He wondered how he could hold the mystery still long enough to examine it and understand it.

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A distant wailing interrupted his reverie.

It grew louder—a siren.

"Here he come," Painter said.

Smeg glanced at Painter. The man was standing beside him glaring in the direction of the siren.

"Here he sure do come," Painter muttered.

Another sound accompanied the siren now—the hungry throbbing of a powerful motor.

Smeg looked toward the sound, saw a dust cloud on the horizon, something vaguely red within it.

"Dad! Dad!" That was Rick on the narrow band.

Before he could send out the questioning thought, Smeg felt it—the growing force of a mindcloud so strong it made him stagger.

Painter caught his arm, steadied him.

"Gets some folks that way the first time," Painter said.

Smeg composed himself, disengaged his arm, stood trembling. Another Slorin! It had to be another Slorin. But the fool was broadcasting a signal that could bring down chaos on them all. Smeg looked at Painter. The natives had the potential—his own Slorin group had determined this. Were they in luck here? Was the local strain insensitive? But Painter had spoken of it getting some folks the first time. He'd spoken of telepaths.

Something was very wrong in Wadeville . . . and the mindcloud was enveloping him like a gray fog. Smeg summoned all his mental energy, fought free of the controlling force. He felt himself standing there then like an island of clarity and calm in the midst of that mental hurricane.

There were sharp sounds all around him now—window blinds snapping up, doors slamming. People began to emerge. They lined the street, a dull-eyed look of expectancy about them, an angry wariness. They appeared to be respectable humans all, Smeg thought, but there was a sameness about them he couldn't quite define. It had something to do with a dowdy, slump-shoulder look.

"You going to see the sheriff," Painter said. "That's for sure."

Smeg faced the oncoming thunder of motor and siren. A long red fire truck with a blond young woman in green leotards astride its hood emerged from the dust cloud, hurtled down the street toward the narrow passage where Smeg had parked his car.

At the wheel of the truck sat what appeared to be a dark-skinned man in a white suit, dark blue shirt, a white ten-gallon hat. A gold star glittered at his breast. He clutched the steering wheel like a racing driver, head low, eyes forward.

Smeg, free of the mindcloud, saw the driver for what he was—a Slorin, still in polymorph, his shape approximating the human . . . but not well enough . . . not well enough at all.

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Clustered around the driver, on the truck's seat, clinging to the sides and the ladders on top, were some thirty children. As they entered the village, they began yelling and laughing, screaming greetings.

"There's the sheriff," Painter said. "That unusual enough fer you?"

The truck swerved to avoid Smeg's car, skidded to a stop opposite the lane where he stood with Painter. The sheriff stood up, looked back toward the parked car, shouted: "Who parked that auto*mo*bile there? You see how I had to swing way out to git past it? Somebody tear down my 'No Parking' sign again? Look out if you did! You know I'll find out who you are! Who did that?"

While the sheriff was shouting, the children were tumbling off the truck in a cacophony of greetings—"Hi, Mama!" "Daddy, you see me?" "We been all the way to Commanche Lake swimming." "You see the way we come, Pa?" "You make a pie for me, Mama? Sheriff says I kin have a pie."

Smeg shook his head at the confusion. All were off the truck now except the sheriff and the blonde on the hood. The mindcloud pervaded the mental atmosphere like a strong odor, but it stopped none of the outcry.

Abruptly, there came the loud, spitting crack of a rifle shot. A plume of dust burst from the sheriff's white suit just below the golden star.

Silence settled over the street.

Slowly, the sheriff turned, the only moving figure in the frozen tableaux. He looked straight up the street toward an open window in the second story of a house beyond the abandoned service station. His hand came up; a finger extruded. He shook the finger, a man admonishing a naughty child.

"I warned you," he said.

Smeg uttered a Slorin curse under his breath. The fool! No wonder he was staying in polymorph and relying on the mindcloud—the whole village was in arms against him. Smeg searched through his accumulated Slorin experience for a clue on how to resolve this situation. A whole village aware of Slorin powers! Oh, that sinful fool!

The sheriff looked down at the crowd of silent children, staring first at one and then another. Presently, he pointed to a barefoot girl of about eleven, her yellow hair tied in pigtails, a soiled blue and white dress on her gangling frame.

"You there, Molly Mae," the sheriff said. "You see what your daddy done?"

The girl lowered her head and began to cry.

The blonde on the truck's hood leaped down with a lithe grace, tugged at the sheriff's sleeve.

"Don't interrupt the law in the carrying out of its duties," the sheriff said.

The blonde put her hands on her hips, stamped a foot. "Tad, you hurt

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that child and I won't never speak to you, never again," she said.

Painter began muttering half under his breath: "No . . . no . . . no . . . no—"

"Hurt Molly Mae?" the sheriff asked. "Now, you know I won't hurt her. But she's got to go away, never see her kin again as long as she lives. You know that."

"But Molly Mae didn't do you no hurt," the young woman said. "It were her daddy. Why can't you send him away?"

"There's some things you just can't understand," the sheriff said. "Grown up adult can only be taken from sinful, criminal ways a slow bit at a time 'less'n you make a little child of him. Now, I'd be doing the crime if I made a little child out of a grown-up adult. Little girl like Molly Mae, she's a child right now. Don't make much difference."

So that was it, Smeg thought. That was the sheriff's real hold on this community. Smeg suddenly felt that a barton had to mean—a hostage.

"It's cruel," the blond young woman said.

"Law got to be cruel sometimes," the sheriff said. "Law got to eliminate crime. Almost got it done. Only crimes we had hereabouts for months are crimes 'gainst me. Now, you all know you can't get away with crimes like that. But when you show that *dis*regard for the majesty of the law, you got to be punished. You got to remember, all of you, that every part of a family is reesponsible for the whole entire family."

Pure Slorin thinking, Smeg thought. He wondered if he could make his move without exposing his own alien origins. Something had to be done here and soon. Did he dare venture a probe of greeting into the fool's mind? No. The sheriff probably wouldn't even receive the greeting through that mindcloud noise.

"Maybe you're doing something wrong then," the young woman said. "Seems awful funny to me when the only crimes are put right on the law itself."

A very pertinent observation, Smeg thought.

Abruptly, Painter heaved himself into motion, lurched through the crowd of children toward the sheriff.

The blond young woman turned, said: "Daddy! You stay out'n this."

"You be still now, you hear, Barton Marie?" Painter growled.

"You know you can't do anything," she wailed. "He'll only send me away."

"Good! I say good!" Painter barked. He pushed in front of the young woman, stood glaring up at the sheriff.

"Now, Josh," the sheriff said, his voice mild.

They fell silent, measuring each other.

In this moment, Smeg's attention was caught by a figure walking toward them on the road into the vil-

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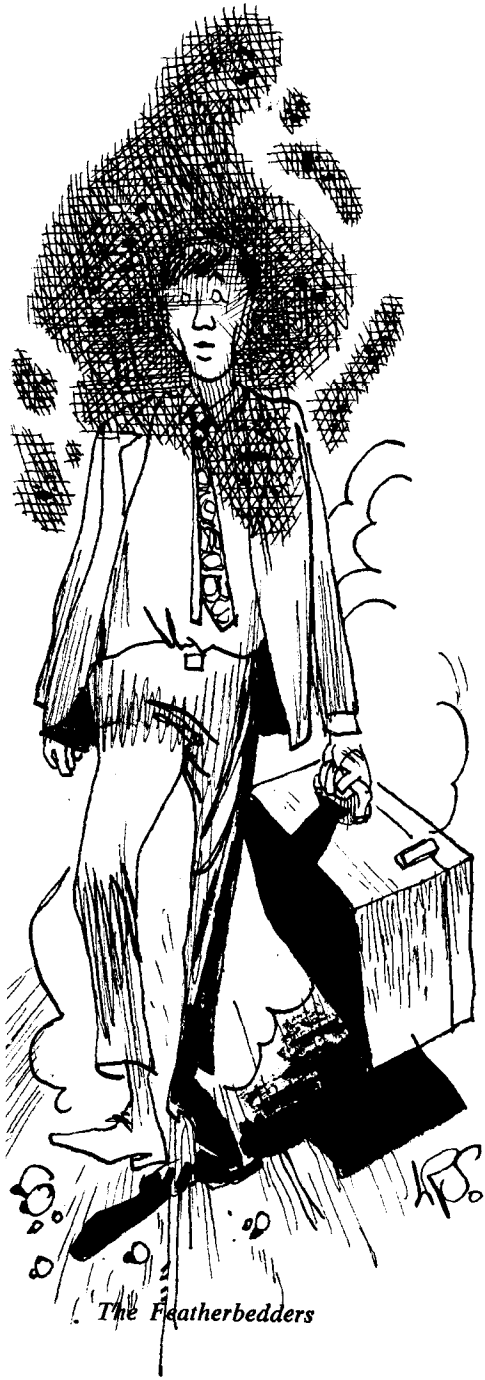

lage. The figure emerged from the dust—a young man carrying a large black case.

Rick!

Smeg stared at his offspring. The young man walked like a puppet, loose at the knees. His eyes stared ahead with a blank seeking.

The mindcloud, Smeg thought. *Rick was young, weak. He'd been calling out, wide open when the mindcloud struck. The force that had staggered a secondary ancestor had stunned the young Slorin. He was coming now blindly toward the irritation source.*

"Who that coming there?" the sheriff called. "That the one parked this car illegal?"

"Rick!" Smeg shouted.

Rick stopped.

"Stay where you are!" Smeg called. This time, he sent an awakening probe into the youth.

Rick stared around him, awareness creeping into his eyes. He focused on Smeg, mouth falling open.

"Dad!"

"Who're you?" the sheriff demanded, staring at Smeg. A jolt from the mindcloud jarred Smeg.

There was only one way to do this, Smeg realized. Fight fire with fire. The natives already had felt the mindcloud.

Smeg began opening the enclosing mental shields, dropped them abruptly and lashed out at the sheriff. The Slorin polymorph staggered back, slumped onto the truck seat. His human shape twisted, writhed.

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"Who're you?" the sheriff gasped.

Shifting to the Slorin gutturals, Smeg said: "I will ask the questions here. Identify yourself."

Smeg moved forward, a path through the children opening for him. Gently, he moved Painter and the young woman aside.

"Do you understand me?" Smeg demanded.

"I . . . understand you." The Slorin gutturals were rough and halting, but recognizable.

In a softer tone, Smeg said:"The universe has many crossroads where friends can meet. Identify yourself."

"Min . . . I think. Pzilimin." The sheriff straightened himself on the seat, restored some of his human shape to its previous form. "Who are you?"

"I am Sumctroxelunsmeg, secondary ancestor."

"What's a secondary ancestor?"

Smeg sighed. It was pretty much as he had feared. The name, Pzilimin, that was the primary clue—a tertiary ancestor from the *Scattership*. But this poor Slorin had been damaged, somehow, lost part of his detail memory. In the process, he had created a situation here that might be impossible to rectify. The extent of the local mess had to be examined now, though.

"I will answer your questions later," Smeg said. "Meanwhile—"

"You know this critter?" Painter asked. "You part of the conspiracy?"

Shifting to English, Smeg said: "Mr. Painter, let the government handle its own problems. This man is one of our problems."

"Well, he sure is a problem and that's the truth."

"Will you let me handle him?"

"You sure you can do it?"

"I . . . think so."

"I sure hope so."

Smeg nodded, turned back to the sheriff. "Have you any idea what you've done here?" he asked in basic Slorin.

"I . . . found myself a suitable official position and filled it to the best of my ability. Never betray your niche. I remember that. Never betray your niche."

"Do you know what you are?"

"I'm . . . a Slorin?"

"Correct. A Slorin tertiary ancestor. Have you any idea how you were injured?"

"I . . . no. Injured?" He looked around at the people drawing closer, all staring curiously. "I . . . woke up out there in the . . . field. Couldn't . . . remember—"

"Very well, we'll—"

"I remembered one thing! We were supposed to lower the crime rate, prepare a suitable society in which . . . in which . . . I . . . don't know."

Smeg stared across the children's heads at Rick who had come to a stop behind the truck, returned his attention to Pzilimin.

"I have the crime rate here al-

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most down to an irreducible minimum," the Slorin sheriff said.

Smeg passed a hand across his eyes. Irreducible minimum! He dropped his hand, glared up at the poor fool. "You have made these people aware of Slorin," he accused. "You've made them aware of themselves, which is worse. You've started them thinking about what's behind the law. Something every native law enforcement official on this planet knows by instinct, and you, a Slorin—injured or not—couldn't see it."

"See what?" Pzilimin asked.

"Without crime there's no need for law enforcement officers! We are here to prepare niches in which Slorin can thrive. And you begin by doing yourself out of a job! The first rule in any position is to maintain enough of the required activity for that job to insure your continued employment. Not only that, you must increase your scope, open more such positions. This is what is meant by not betraying your niche."

"But . . . we're supposed to create a society in which . . . in which—"

"You were supposed to reduce the incidence of violence, you fool! You must channel the crime into more easily manageable patterns. You left them violence! One of them shot at you."

"Oh . . . they've tried worse than that."

Smeg looked to his right, met Painter's questioning gaze.

"He another Hungarian?" Painter asked.

"Ah-h-h, yes!" Smeg said, leaping at this opportunity.

"Thought so, you two talking that foreign language there." Painter glared up at Pzilimin. "He oughta be dee-ported."

"That's the very thing," Smeg agreed. "That's why I'm here."

"Well, by gollies!" Painter said. He sobered. "I better warn you, though. Sheriff, he got some kind of machine sort of that scrambles your mind. Can't hardly think when he turns it on. Carries it in his pocket, I suspect."

"We know all about that," Smeg said. "I have a machine of the same kind myself. It's a defense secret and he had no right to use it."

"I'll bet you ain't Department of Agriculture at all," Painter said. "I bet you're with the CIA."

"We won't talk about that," Smeg said. "I trust, however, that you and your friends won't mention what has happened here."

"We're true blue Americans, all of us, Mr. Smeg. You don't have to worry about us."

"Excellent," Smeg said. And he thought: *How convenient. Do they think me an utter fool?* Smoothly, he turned back to Pzilimin, asked: "Did you follow all that?"

"They think you're a secret agent."

"So it seems. Our task of extracting you from this situation has been facilitated. Now tell me, what have

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you done about their children?"

"Their children?"

"You heard me."

"Well . . . I just erased all those little tracks in their little minds and put 'em on a train headed north, the ones I sent away to punish their folks. These creatures have a very strong protective instinct toward the young. Don't have to worry about their —"

"I know about their instincts, Pzilimin. We'll have to find those children, restore them and return them."

"How'll we find them?"

"Very simple. We'll travel back and forth across this continent, listening on the narrow band. We will listen for you, Pzilimin. You cannot erase a mind without putting your own patterns in it."

"Is that what happened when I tried to change the adult?"

Smeg goggled at him, senses reeling. Pzilimin couldn't have done that, Smeg told himself. He couldn't have converted a native into a Slorin-patterned, full-power broadcast unit and turned it loose on this planet. No Slorin could be that stupid! "Who?" he managed.

"Mr. McNabry."

McNabry? McNabry? Smeg knew he'd heard the name somewhere. *McNabry? Widow McNabry!*

"Sheriff, he say something about Widow McNabry?" Painter asked. "I thought I heard him—"

"What happened to the late Mr. McNabry?" Smeg demanded, whirling on Painter.

"Oh, he drowned down south of here. In the river. Never did find his body."

Smeg rounded on Pzilimin. "Did you—"

"Oh, no! He just ran off. We had this report he drowned and I just—"

"In effect, you killed a native."

"I didn't do it on purpose."

"Pzilimin, get down off that vehicle and into the rear seat of my machine over here. We will forget that I'm illegally parked, shall we?"

"What're you going to do?"

"I'm going to take you away from here. Now, get down off of there!"

"Yes, sir." Pzilimin moved to obey. There was a suggestion of rubbery, nonhuman action to his knees that made Smeg shudder.

"Rick," Smeg called. "You will drive."

"Yes, Dad."

Smeg turned to Painter. "I hope you all realize the serious consequences to yourselves if any of this should get out?"

"We sure do, Mr. Smeg. Depend on it."

"I am depending on it," Smeg said. And he thought: *Let them analyze that little statement . . . after we're gone.* More and more he was thanking the Slorin god who'd prompted him to change places with Rick. One wrong move and this could've been a disaster. With a

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curt nod to Painter, he strode to his car, climbed into the rear beside Pzilimin. "Let's go, Rick."

Presently, they were turned around, headed back toward the state capital. Rick instinctively was pressing the Plymouth to the limit of its speed on this dirt road. Without turning, he spoke over his shoulder to Smeg:

"That was real cool, Dad, the way you handled that. We go right back to the garage now?"

"We disappear at the first opportunity," Smeg said.

"Disappear?" Pzilimin asked.

"We're going pupa, all of us, and come out into new niches."

"Why?" Rick said.

"Don't argue with me! That village back there wasn't what it seemed."

Pzilimin stared at him. "But you said we'd have to find their children and—"

"That was for their benefit, playing the game of ignorance. I suspect they've already found their children. Faster, Rick."

"I'm going as fast as I dare right now, Dad."

"No matter. They're not going to chase us." Smeg took off his western hat, scratched where the band had pressed into his temples.

"What was that village, Dad?" Rick asked.

"I'm not sure," Smeg said. "But they made it too easy for us to get Pzilimin out of there. I suspect they are the source of the disaster which set us down here without our ship."

"Then why didn't they just . . . eliminate Pzilimin and—"

"Why didn't Pzilimin simply eliminate those who opposed him?" Smeg asked. "Violence begets violence, Rick. This is a lesson many sentient beings have learned. They had their own good reasons for handling it this way."

"What'll we do?" Rick asked.

"We'll go to earth, like foxes, Rick. We will employ the utmost caution and investigate this situation. That is what we'll do."

"Don't they know that . . . back there?"

"Indeed, they must. This should be very interesting."

Painter stood in the street staring after the retreating car until it was lost in a dust cloud. He nodded to himself once.

A tall fat man came up beside him, said: "Well, Josh, it worked."

"Told you it would," Painter said. "I knew dang well another capsule of them Slorin got away from us when we took their ship."

The blond young woman moved around in front of them, said: "My dad sure is smart."

"You listen to me now, Barton Marie," Painter said. "Next time you find a blob of something jes' lyin' in a field, you leave it alone, hear?"

"How was I to know it'd be so strong?" she asked.

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"That's jes' it!" Painter snapped. "You never know. That's why you leaves such things alone. It was you made him so gol dang strong, pokin' him that way. Slorin aren't all that strong 'less'n you ignite 'em, hear?"

"Yes, Dad."

"Dang near five years of him," the fat man said. "I don't think I coulda stood another year. He was gettin' worse all the time."

"They always do," Painter said.

"What about that Smeg?" the fat man asked.

"That was a wise ol' Slorin," Painter agreed. "Seven syllables if I heard his full name rightly."

"Think he suspects?"

"Pretty sure he does."

"What we gonna do?"

"What we allus do. We got their ship. We're gonna move out for a spell."

"Oh-h-h, not again!" the fat man complained.

Painter slapped the man's paunch. "What you howling about, Jim? You changed from McNabry into this when you had to. That's the way life is. You change when you have to."

"I was just beginning to get used to this place."

Barton Marie stamped her foot. "But this is such a nice body!"

"There's other bodies, child," Painter said. "Jes' as nice."

"How long you think we got?" Jim asked.

"Oh, we got us several months. One thing you can depend on with Slorin, they are cautious. They don't do much of anything very fast."

"I don't want to leave," Barton Marie said.

"It won't be forever, child," Painter said. "Once they give up hunting for us, we'll come back. Slorin make a planet pretty nice for our kind. That's why we tolerates 'em. Course, they're pretty stupid. They work too hard. Even make their own ships . . . for which we can be thankful. They haven't learned how to blend into anything but a bureaucratic society. But that's their misfortune and none of our own."

"What did you do about the government survey people?" Smeg asked Pzilimin, bracing himself as the car lurched in a particularly deep rut.

"I interviewed them in my office, kept it pretty shadowy, wore dark glasses," Pzilimin said. "Didn't use the . . . mindcloud."

"That's a blessing," Smeg said. He fell silent for a space, then: "A damn poem keeps going through my head. Over and over, it just keeps going around in my head."

"A poem, you said?" Rick asked.

"Yes. It's by a native wit . . . Jonathan Swift, I believe his name was. Read it during my first studies of their literature. It goes something like this— 'A flea hath smaller fleas that on him prey; and these have smaller still to bite 'em; and so proceed ad infinitum'." ■

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COWS CAN'T EAT GRASS

Which sounds nuts,
but isn't and honors an ancient custom of
Terrestrian life called "symbiosis"!

WALT and LEIGH RICHMOND

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Harry Gideon stretched his lean, hard frame and looked up at the sky —a light purplish sky—shaking himself awake for the day.

They should be here soon now, the Galactic Survey Team that would rescue him. It was a triumphant thought. He would be here, alive, for them to find. The wrecked scout, the destroyed and burnt landing craft, the lost supplies, even the spider bite: he'd survived them all.

The rude tree-house shelter, built of small branches loosely woven into the lower limbs of a large tree, shook and swayed as he rolled to his feet, grasped his rough quarterstaff, and jumped lightly to the ground. Six months ago he couldn't have made that jump, he thought, recalling how he had climbed painfully that first night into this same tree. His frame, then, had been bulky and bulgy, and he had been quite ill —he had come a long way, for somebody who was grateful still to be in the same place!

He made his way to the wreck of his landing craft, scorched almost beyond recognition. He was as always alert to every sound of the forest, automatically identifying the various sibilances and whistlings, for all he was certain nothing dangerous to him sang in that chorus. He was not just swinging his quarterstaff in readiness but actually using it to bend back loose whipping branches and to break a way through thickets wherever the path was too narrow. He skirted the sunlit place where the big snake lived—poisonous or harmless he didn't know—and at last poked his head into the wrecked, but at least partially unburned, cabin to check on the still-functioning passdar receiver, one of the few instruments that had partially survived. With only one of its eighteen gigacycle antennae still operating, it could no longer completely live up to its name—the passive ambient signal could be surveyed for direction, but not for range.

But that didn't matter too much now. Any object in orbit around the planet would generate its own distinctive signal due to the ambient temperature difference from its background, and would emit detectable microwaves. The orbital velocity of the object would provide an easily calculated range, roughly checkable against his own derelict—thus providing a range gauge of sorts.

The blip in orbit that was his own ship, and that he was receiving by its own radio-thermal emission, was down near the horizon and . . . and—yes! There was another blip with it. There was another ship, besides his own derelict, in orbit. The Galactic Survey Team had arrived. Perhaps they had already been scanning for his landing craft during the hours he had slept.

Turning, he ran toward the big pile of brush carefully collected over the last six months—his signal flare. Then he checked himself. Not yet.

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The passdar image showed that the two ships would be below the horizon within minutes now, insufficient time for the signal flare to put on a large enough cloud of smoke.

Tensely he turned back to the remains of his landing craft to wait out the hour and a half before it would be time to light the signal fire.

Commander Cal Davis of Galactic Survey had inspected the orbiting scout personally, and he knew that it was probable that the explorer within survived when the rock that made the ship a derelict went through. The landing craft was missing, either out at the time of impact or used as a life raft afterward. Either way, Gideon might have made it down to "safety."

He stood now staring at the projected telescopic image of the planet below. Friendly or hostile? If the explorer had reached the planet—a big if, though his landing craft was nowhere to be found in orbit—could he have survived six months alone down there? Atmosphere and gravity were within acceptable limits. The man, Gideon had sent back word of a "probable" planet find before the short, sudden, Mayday. But there was no homing beacon from a landed craft; and as yet they had been able to pinpoint no wreck.

Well, he'd search for signs of survival for one more rotation of the planet below, and then land his team for planet analysis whether or not the scout had survived.

"Smoke smudge, sir." The formal, clipped tones of the observer broke into his thoughts. "Coming up about the 38th parallel. Same place we got a pinpoint metallic reading on the last orbit. Just about two hours past the dawn line now."

"Shift orbit," Cal spoke to his pilot. "Put us as close across that point as you can. Observation, I want the best pics, passdar readings, magnetometer survey, and anything else you can get on that area."

The replies were lost in his surge of excitement. Perhaps Gideon *had* been one of the lucky five per cent that managed to survive a loner downing.

"It's a small fire for a natural occurrence, and a large one if it's manmade, sir. And yes, there it is, that's what's probably the drogue-shute spread out on some trees. The fire's in the middle of a large, a very large, clearing."

"Magnetometer reading, sir. There's metal down there. Could be a landing craft, though it's pretty scattered."

"Passdar reading, sir. Definitely fragments of metal."

"Maybe Harry survived, sir?"

"Let's not jump to any conclusions yet. That fire could still be a natural phenomenon, or the work of natives." Cal remembered wryly the time when natives on another planet had made an idol of a wrecked landing craft.

"Observation, get a spread of pics around here and put them through

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the computer for possible good landing sites near the area."

"Yes, sir." This time the perfunctory reply registered with him.

Harry Gideon turned from the blaze of the signal fire and strode off into the jungle in search of breakfast. The survey team would see it, but that didn't mean they'd be here immediately. His landing craft hadn't made it out of the wrecked scout undamaged and had been nearly out of control from the start. His landing site had been a matter of chance, not choice. And, as far as he had been able to judge it from recalled glances at the surrounding areas as he had fought his craft to a catastrophic, but not completely disastrous, landing, the nearest proper landing site was a lake a good four hundred fifty miles southwest.

But that didn't mean they'd be here in a week, granted they picked that spot to land. Any survey team worth its salt wouldn't risk its members until they'd checked the environment and the ecology and knew what a rescue party by 'chopper would be up against. They'd figure he had survived—if they figured he had—six months, and that he could survive at least a month longer.

Then, too, there would be a lot to occupy them—setting up base, putting up weather survey and com satellites, landing and assembly of labs and choppers, and full field equipment. After all, they weren't here just to rescue him. As a matter of fact, he would be almost incidental.

But at least they were here now. He could begin measuring rescue time in weeks rather than in months or years.

Radio messages for him would be covering every band, but that was of no use. There hadn't been enough electronic equipment that escaped the burning and crushing to make either transmitter or receiver. And his passdar unit, the only operating device left in the entire landing craft, was of the most modern, undetectable type, so even it would tell them nothing about his existence.

Of course he could have built a spark-gap transmitter that would serve as a homing beacon, and now that they had surveyed the planet sufficiently to know that there was no native radio on the air they could use it to home in on. But that wasn't necessary. They'd spot the fire and the drogue chute and probably the metal of the landing craft as well; even if they didn't, they would land and set up a base. Of course, they'd find the planet habitable as he had; and if *they* didn't find him, the colonists would—after a colony was established. Or, he could go find them. But not yet. His orders were to stay with his craft until "located or reasonably certain that location would not be made."

Six months ago it would have been a different story, he realized. He would have been frantic in seconds at the thought that another hu-

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man being was on the same planet. But six months of survival had changed that. Now, there wasn't much hurry at all.

The breakfast tree was right ahead of him. Harry reached into the thicket of small brush and pulled out the long pole with the crook on the end of it that he used for the purpose of collecting breakfast. He was late this morning. The sun-warmed fruit might already be inedible. If it was, that meant a day without eating, so he would look. Experience had taught him that breakfast fruit must be picked not more than two hours after dawn, before it had lost a lightly greenish color that it took on during the cool of the night. Otherwise it was worse than useless to eat it. And it was also useless to eat anything else.

Experience had taught him that, too: no breakfast, no lunch *or* supper. The sensitive changes were brought about, so far as he could determine, by temperature, or some subtle alteration in this planet's chemistry. His stomach had been the only laboratory handy, and his experiments had cost him merely thirty pounds—of blubber.

With a practiced eye he scanned the lower branches and found some of the fruit that still looked edible. But tomorrow he would have to be early. This was the last of the low, well-shaded fruit.

There was a ripping roar of wings beating for rapid altitude, but Harry was barely startled. The birds seemed to depend on this startle-mechanism, waiting almost until you stepped on them, and then suddenly scattering in all directions. Amused, he watched the last and slowest of the lot go careening wildly through a clearing in the branches, then reached up and knocked down some breakfast.

"Sir?"

Commander Cal Davis looked up. Pat Carver, the bio-technician, was young and very earnest and the freckles that sprinkled her upturned nose belied the heavy frown that brought sandy eyebrows together.

"Sir, my test animals are dying. Not one of the possible local foods seems to be edible by Earth-life. It's not that they're poisonous, though some of them are, it's just that they darned well don't provide any nourishment. Not a bit. The chemicals are there—the right quantities of carbon, oxygen, hydrogen, phosphorous, et cetera—but they're not digestible. The sugars are tied up as polysaccharides similar to cellulose back on Earth, and other undigestible substances. From the available data I have to conclude that a human could not possibly survive on this planet without extensive assistance. And . . . Well, a couple of my animals died in convulsions, though that . . ."

Behind her, the ship's agronomist, Jacques Sinclair, spoke up. "That goes for Earthside plants as

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well, sir. They can be grown here quite readily by hydroponics techniques, but something seems to interfere with their chemistry—they literally refuse to grow, or starve, you might say, when planted in the local soil. A very few of our hardier grasses have survived, but of these only one type actually tries—a type that's noted back on Earth for its absolute uselessness."

Cal raised his eyebrows. "I thought you only tested for the most useful plant life adaptations?"

"Yes, sir, but as a general check we also carry such pests as crabgrass. And that's the only thing from Earth that really grows well here."

"Hm-m-m." Cal pondered thoughtfully. "I have reports here that there are few hostile species of animal. There's one type of insect similar to a spider that's capable of giving a man quite a hard time. Its bite seems to be deadly, at least to one monkey, though it probably is not more than just serious so far as a man would be concerned. Raw materials are available for any form of civilization. The weather extremes are milder than they would be on Earth. We have found no evidence of intelligent native life, with the possible exception of that fire we observed shortly after we arrived. Except for the food problem, a man or a colony could survive—but unless the food problem could be solved, then a colony would be dependent on hydroponics and the chances of a total colony failure would be relatively high from a simple crop failure in case something went wrong with the hydroponics."

"That would seem rather unlikely," Jacques broke in. "We would certainly set up multiple facilities around the planet, so that even major storms could hardly upset a full-scale colonization program."

"Unless you depend on hydroponics," Pat Carver answered seriously, "I don't think this planet would be suitable for colonization." The bio-tech unconsciously chewed on her upper lip in concentration. "There's just no food here, sir."

"But, carrying their own food, and being wary of spiders, I gather a search crew for Gideon will be safe enough." Cal stretched back in his desk chair. "The matter of colonization actually won't be up to us anyhow. And I believe we're ready enough to send out a search party. As you say, we probably won't find him. But we should pick up anything he may have left and our stay here is just about over. So tomorrow morning . . ."

"Request permission to go along!" Both of them spoke eagerly, and Cal glanced up, amused.

"O.K. You two and one med-tech, in copter Seven. I'll send another copter along as well. But remember, if you find Gideon, every precaution is still to be taken. From what we have learned, his survival is extremely unlikely. But the fire looked

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man-made; and from the pictures that drogue chute was spread by hand. You should bear in mind, however"—his face took on a stern look as he gazed at the two—"what a variety of life forms might exist in the galaxy. And you should take no chances that another life form might have utilized Gideon's knowledge of how to bring us down in this area. Nor will you ignore any other possibilities, such as contagion."

"Yes, sir." The two seemed solemnly impressed.

It was near noon and Harry Gideon was using a stone hoe, lashed to a short supple hoe, to dig for the roots of the steak-lunch plant, when he heard the mechanical sound of a chopper crawling slowly through the air along the side of the far hill.

Hastily gathering up a couple of the succulent roots that he had already unearthed, he began a light trot to the clearing where his lookout tree had long since been provided with a piece of the brightest metal he had been able to pull from the wreck.

Without giving it a second thought he leaped for a low-hanging limb and swung himself into the tree, most of his senses concentrated on the rising and falling sound of motorized equipment that for the first time in nearly seven months broke the pastoral quiet.

Hastily he snatched up the carefully selected "mirror" of metal, polished on both sides. He had practiced signaling with it for months. The hole in its center would pass sunlight through to the ground or other object below. By eye, he could sight through the same hole at a distant object. Using the rear reflective surface, he could also see the dancing spot of light on the ground. By matching that exactly with the hole, he would be reflecting a beam of light at the object sighted through the hole. It was an elementary signaling system, but one that had taken much practice.

There in the distance, the chopper was passing. But he couldn't get a clear sight. Frantically he scrambled for a higher branch, but the chopper was past him now.

Harry felt a surge of despair, and then realized that the fading sound of the chopper was being echoed rather loudly. No—it was another chopper.

Quickly he swung around and began signaling. The chopper paused, seeming like a playful, fat dragonfly.

Harry signaled again, and the chopper blinked back. The standard *dit dit dit, dah dah dah, dit dit dit,* had been answered, and Harry began signaling instructions. L-a-n-d . . . a-t . . . s-i-g-n-a-l . . . f-i-r-e . . . h-a-r-r-y.

The chopper signaled acknowledgment and turned off; and as Harry swung down from the tree he noted that the other chopper had turned back.

As he broke into the clearing, an amplified voice from the chopper

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suddenly stopped him in his tracks.

"Hold where you are. Don't move a step farther." The muzzle of a snub gun on the front of the chopper raised towards him to emphasize the words.

A frustrated grimace went over his face. So they were going to play it by the book. Well . . .

"I'm Harry Gideon, explorer scout," he said. "Identity number C-305-9728. Spider-bit, but otherwise unhurt. Request permission to greet the first humans I've seen in seven months." He grinned and waved his quarterstaff.

Only one of the choppers had landed. The other would remain aloft, both for certainty of communication and as sentry, until the exploration party was convinced that it was safe enough to set up a base here.

"Stand where you are, please. And drop your weapons."

Harry almost laughed out loud. "Weapons?" Then he realized that actually the quarterstaff *was* a weapon. Carefully, he laid it down.

"Sidearms, too."

Sheepishly, Harry felt along his belt, and sure enough there was the regulation blaster, a device he had hardly been aware of in the last six months, since it had no practical use in this environment.

"I'd forgotten all about that," he mumbled, and dropped it beside the quarterstaff. They were being very, very correct when "faced by native life," and suddenly Harry began to chuckle. The inanities of going by the book!

"O.K.," he called, "weapons down. Now are you going to say hello to a fellow human, or are you going to keep me standing here?"

The voice that answered him was apologetic, but firm. "Look, if it's you, Gideon—and you don't match your ID description worth a damn —O.K. We hope it is, and we'll be willing to congratulate you after we've proved it. But our information says you *couldn't* have survived here. It's not possible. Therefore, we've got to assume that you're not you until we prove otherwise."

"Well, if I'm not me who the devil do you think I am? And what makes you think I couldn't survive here?" he asked. He was beginning to lose his good humor.

"The food here won't support human life. We've proved that. And by the looks of your landing craft, you didn't bring an ecolotank down in one piece. But you've been here for seven months. Therefore . . ."

"Nuts. The food here supports human life very well. I eat it. But I sure would like a good steak. Anyhow, how do you propose for me to prove I'm me? Tell you stories of Earth? Sit on the ground and tell sad stories of the deaths of kings?" There—Shakespeare ought to convince them.

"No. If you've been taken over by some symbiotic life form, or if you're an imitation, you'll have Harry Gideon's memories. At least

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that seems a reasonable assumption by what we've observed so far."

"Then just how *do* you expect me to prove I'm me? How about if I tell you the number and type of satellites you have in orbit? The types would be a guess but the passdar scanner says there are a total of eight satellites in orbit, and . . ."

"No. Same objection. You could also know about passdar and satellites. Darned if I know how, but we'll think of something."

Harry sat down on the grass, pulled one of the steak plants out of his belt and began to chomp on it. "This may be a long job," he remarked conversationally. "If you're hungry, I've got a steak plant here. I'd be willing to trade. Maybe you've got some coffee?"

It was another voice, a feminine voice, that replied now, and it was bitterly cold. "I've seen five test animals die—of convulsions—from one of your steak plants."

Harry noted the "your" steak plants, and realized that that speaker at least had made up her mind that Harry had been taken over by a native life form.

The third voice was more congenial. "We've got coffee here. Wouldn't it be safe enough to have him back up and we'll leave a pot of coffee for him and some food?" Suddenly the loudspeaker went dead and Harry could imagine the argument that raged behind the silence.

At last the argument evidently was resolved. The speaker opened up again. "We will deposit food here, and back off. You are instructed to remain exactly where you are until we have done so."

It was only minutes later that Harry was allowed to advance and pick up the first Earth food he had seen since the landing-craft disaster. The synthaburger looked delicious. And the coffee . . .

Harry squatted on the ground and began to eat frantically. He was beginning to form a plan. If . . .

The nausea hit him suddenly and completely, and the vomiting was followed by cramps so violent that he doubled in agony.

Somewhere out of the blackness there was a voice. With supreme effort he concentrated on the chopper. The muzzle of the gun was leveled at him again.

Anger gorged through his aches. "You're supposed to be humans," he spat at the chopper. "Yet you sit there and watch a fellow human die. I survived this planet, but I wonder if I can survive the . . ."

The voice that answered now was steel-cold. "I have watched Earth animals die of convulsions from your food," it said. "Now I think I am watching a native of this planet nearly die of Earth food, though evidently you did not eat enough. What have you done with Harry Gideon?"

His mind was beginning to clear now, and Harry began finally to

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realize what he was up against. They quite literally didn't believe that he was himself. Agreed that he had lost his bulgy figure; agreed that he was stronger, slender, hard. And agreed, too, he thought, that a bite of hamburger and a cup of coffee had given him cramps . . . convulsions? It must have been, for he had passed out.

Suddenly the whir of a starter broke the stillness, and Harry's attention jerked to the chopper, and a voice, a feminine voice, a distressed voice: "Oh, no! We *can't* just leave him!" and another that answered bitterly, "We have to."

Then the latter voice addressed him. "I don't think you're Harry Gideon," it said, "but if you are—good-bye—and good luck. Even if the evidence were not as strong as it is, we couldn't take a chance on—infecting—the whole human race."

As he spoke the rotors of the chopper began to turn slowly, the vehicle rose from the ground.

Harry felt his jaws clench. He, a scout, selected for his ability to meet the problems presented by possible life forms, was defeated by a type of mind with which he had been born and raised, by the by-the-book thinking of his own species.

Or was he? A hard core of stubbornness formed. Think of them as aliens, he told himself. Look at them as aliens—and find a solution.

With an effort he forced his body to relax, forced a slow grin onto his face, forced himself to his feet.

"Never mind," he said, turning as though to go off into the woods and speaking over his shoulder, "you may have figured me out, but you're too late anyhow. We're aboard your ship. Every shoe that's touched this planet has taken us aboard. And within two weeks, just as you reach Earth, we'll have you as our own. When you land . . . ah! We thank you for having brought us a new planet."

He moved on, pretending to leave and then, as if struck by an afterthought, turned back. "You seem hard to convince," he said. "Suppose you take samples of your—contaminated—blood. And take a sample of mine with which to compare it? I don't mind, you know. I'll even help. Toss me a sterile syringe, and I'll take the sample for you, and you can handle it with all the best procedures to protect you from any infections you may not yet have gotten. And I'll give you an outline of my . . . of our . . . diet.

"And, oh yes," he added slowly, "I'll come by your camp in two weeks to check on your progress."

It took Harry ten days of the two weeks he'd given them as a deadline to make his way to the major campsite. They hadn't left. He'd known they wouldn't—couldn't afford to. If they *were* infected, they had to remain and destroy him, their craft and themselves, to protect mankind. They were a by-the-book survey team, and they'd play it

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that way. They had to. It was how their minds worked.

Carefully he scouted the campsite. If they'd found the answer, he was safe. If they hadn't they'd shoot to kill. But there was no way of knowing.

Finally he took a piece of bark and a carboned bit of wood he'd carefully prepared from his last campfire, and wrote a message. "Have you found the answer yet? I'm me; you're you. Harry." He wrapped the bark around the shaft of his quarterstaff, waited until the darkest part of night, and heaved it into the campsite as far as he was able. Then he climbed a tall tree to watch and wait.

When the answer came, it was blared toward the woods from a loudspeaker.

"Harry Gideon. Come in. We have the answer. You're safe."

It might be a ruse, he realized, but somehow he didn't care greatly. He wanted to go home to Earth. The muscles of his stomach seemed to care, though, for they tightened spasmodically against the possible bullets as he strolled toward the main hall of the camp—to be greeted by a bedlam.

"Don't eat our foods yet!" somebody called almost as he appeared. "We'll have you back to normal in twenty-four hours, but it might be fatal now!"

"Why in hell did you have to scare the pants off us that way? We might have committed suicide!"

"A colony *can* be independent here!" This last from a pert young lass with freckles on her nose. "If you hadn't done what you did, we'd never have found it!"

"O.K." Harry was grinning, his muscles loosening slowly. "But what's the answer? I'm interested, you know."

The voices answered all at once.

"You got bit by that spider thing and it gave you an injection . . ."

"You really *did* pick up an alien symbiote, only it wasn't running you, it was working for you . . ."

"Like a cow. A cow can't eat grass . . ."

Suddenly the whole group was in an uproar of laughter.

"Whoa, there," said Harry, "one at a time, one at a time! Bacteria, alien symbiotes, and who says cows can't eat grass? They do!"

It was the pert one with the freckles who took over.

"Yes, of course. They *do* eat grass, but what I meant to say is they don't, not really. The cow takes in the grass, but then a bacterium, a bio-symbiote, actually digests it. Breaks down the cellulose to sugars that the cow *can* live on.

"But this system isn't even quite that simple. You *had* to have breakfast fruit and steak-lunch plant, and then you were free to eat an evening meal of anything you liked. The bacteria, here, were on the spider thing's feet, and migrated into the spider-bite. They were benign, but they required an enzyme from

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the green mold on the 'breakfast fruit.' That was the hardest part to find out. Even after we discovered the bacteria-symbiote, it didn't come out right until we caught on to the green mold from the breakfast tree. I had been disregarding that part and picked the ripest fruit that didn't have the mold—but it was the mold that provided the enzyme that helped the digestive system. But then, my animals had also died of convulsions after eating the steak-lunch plant. You didn't, but you would've if you hadn't, because the steak-lunch plant counteracted the enzyme from the mold and completed the cycle, and . . ."

Harry smiled down into the earnest eyes. "Explorer's luck," he said softly. "I thought it had deserted me. That day when I crashed, and had hardly gotten away from the fire when I got bit by a 'spider' . . . I wasn't sure I'd make it. When I was finally able I crawled back to the wreck of the landing craft to find something to eat and there wasn't a *thing*, not a *single thing* that hadn't been burnt. That seemed the final disaster, but I always did let my body tell me the answers and it answered that one. Then the ship came and the chopper and it was going to leave without me. . . .

"It was your voice, wasn't it, that said no? It was a warm, kind voice and it held the promise of all the good things of Earth . . . but they were taking it away and I'd never see Earth again." Harry shuddered.

"Explorer's luck," he said again, still gazing down into the now-sparkling eyes of the bio-tech. "It's the blackest black on the outside, but it's pure gold in the middle. That's the explorer's job—to turn it inside out." ■

COVER PRINTS AVAILABLE

The Bonestell cover on this issue is being made available in print-free form on a special high-quality paper suitable for framing—as we did with last January's cover.

The close-up view of a red giant against a background of a globular star cluster will be sent—packed protectively for mailing—for $1.50.

Incidentally, the demand for the January supernova cover ran so high and so quickly that our original supply was exhausted almost immediately—so quickly that the printing plates were still available and we were able to run off another—and doubled!—order of them!

The supernova cover prints are still available at $1.50—about one hundred twenty-five of them, that is. And that will be the end of them, because the plates are no longer usable.

Send your order for either or both to Analog, Dept. BB-3, P.O. Box 1348, Grand Central Station, New York, N. Y. 10017.

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Depression or Bust

On the principle of "Cause and Effect," there must be some cause for any effect. Sometimes it's difficult to isolate, but it should be possible to reverse a depression . . .

MACK REYNOLDS

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The way the computers checked back on it later, it all began at the home of Marvin and Phoebe Sellers, 4011 Camino de Palmas, Tucson, Arizona.

Marv Sellers, at 7:30 p.m. on a Friday in May was going over his assets and liabilities, in the two-bedroom pseudo-ranchhouse they had been making payments on the past five years. It had taken him a good two hours before he came up with his history-shaking conclusions.

He grimaced when his pencil made a black mark on the end of his nose. "Phoebe," he said, "there is no other way of working it out. No other way."

"How'd you mean, Marv?" Phoebe said. She was heating up three dinners.

"That new deepfreeze'll hafta go back. What in the heck was wrong with the old one, anyways?"

"The old one?" She thought about it, not particularly upset. The Sellers family didn't really need a deep freeze. The freeze compartment of the refrigerator was sufficient, their diet consisting largely of prepared frozen and canned meals.

"Why, Marv, you know we had that old deepfreeze nearly onto four years. The new ones had a lot of improvements. It was in all the ads, on the Tri-Di and all. And we got a good turn-in price on the old one."

"Old one wasn't even paid for yet," Marv said gloomily. "What new improvements?"

"Well, the old one was colored white, like. Nobody has a white deepfreeze any more. Out of date."

Marv said, "Anyway, we gotta send this one back to the store. We just can't stretch out the payments, what with the house and the car and the furniture and swimming pool and that there vacation we took —rocket now, pay later."

"They ain't going to like that at the store."

"Then they'll hafta lump it."

Old Sam had come in toward the end of the conversation. He said, "Back when I was a boy, we usta have an icebox. Ice man usta come around in an ice wagon. Us kids usta swipe small pieces of ice often the wagon and suck on them. We usta have fun in those days. Kids watch Tri-Di now."

"I'll bet, Gramps," Marv muttered.

Harry came around to Jim Withers and said, "Boss, I just got a call from Marv Sellers. Says he can't keep up the payments on that deepfreeze he bought a few weeks ago."

Jim Withers glowered at his sole clerk.

Harry shrugged. "Not my fault."

Jim Withers thought about it. He looked around the shop, darkly.

He said finally, "Maybe we can resell it for new. Listen, call the distributor up in Phoenix and tell him to cancel that order for three new deepfreezes. We're overstocked in here. Hardly get around."

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"O.K.," Harry said. "But the customers like to see a variety. Green, pink, cerise, violet . . . gotta match their other kitchen things."

"Let me worry about that," Withers snarled. "And listen. How're those gadgets moving?"

"What gadgets, Mr. Withers?"

"The nuclear Martini stirrers, the electric combs, the electric toothbrushes and the nuclear backscratchers. At any rate, they're all on consignment. Send 'em back."

Jim Withers turned on his heel and entered his small office. He was in a vile mood.

He sat down and thought for a while, then switched on the phone and dialed.

When a girl appeared in the screen, he said, "Let me have Bill Waters."

When Bill Waters appeared in the screen, Withers said, half defiantly, half apologetically, "Listen, Bill. I'm going to have to postpone that Buick Cayuse air-cushion."

Waters argued, and ended up with, "You're a three-car family, Jim. You need that Cayuse."

"I can do without it for a while," Withers said. "Maybe I'll drop around and see what you have on the used-car lot."

"You're the boss, Jim. Any time. But I sure think you ought to reconsider on the Cayuse. You realize these new models have nearly a thousand horses under the hood?"

Jim Withers sighed and said, "See you later, Bill."

"O.K." Bill Waters flicked off the screen and turned to his secretary.

He grimaced and said, "Hell."

"I beg your pardon," the secretary said.

"Miss Harding, write to Detroit and tell them to cut back on our allotment. Oh, two cars a month, in each line. Tell them I'll up it again when business picks up."

"Gosh, Mr. Waters. All on account of one cancellation? This year started off awful good."

He looked at her glumly. "I can sense a trend. Jim Withers must be taking a beating in that appliance store of his. Cars'll be next. I don't want to be overstocked with this six-monthly model."

He sat there in thought for a while. Finally, he switched on the phone again and dialed unhappily.

When the screen lit up, he said, "Frank, I've been thinking over that new house. I think we better shelve it for now."

Marv Sellers came into the house from the back, the way he always did when he returned from work. He threw his hat on the kitchen table in disgust.

Old Sam looked up from where he sat in his rocker and said, "What's wrong?"

"Where's Phoebe?"

"She ain't home from work yet."

"Well, the contractor just laid me off," Marv said. "Me and eight of the other guys."

"What happened?"

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"Ahhh, the house we was going to be working on, the guy who wanted to buy it changed his mind. That Bill Waters over to the Buick agency. Business must be bad. Well, it's me for rocking-chair money for a while. But you can't make ends meet on a hundred a week unemployment insurance." He grunted disgust. "We'll hafta send back that new couch and easy chair Phoebe bought."

The old man said, "Lucky you still got the old ones out to the garage. Business bad, eh? I'll hafta talk that over with the boys in the park in the morning."

Marv opened the refrigerator for a plastic of beer.

"Glad Phoebe's working," he grumbled. "Don't know how long it'll be before I get another job."

Phoebe came in and he told her about it.

She was her usual placid self.

"It's not important," she soothed him. "You'll have another job in no time at all. But meanwhile, it takes a little thinking. We'll have to retrench, like they say."

She laughed sourly. "This would have to happen on the night I wanted you to take me to June Perriwinkle's restaurant. Now I think I'd just better cook something here."

"Well, that's one good thing," Marv snorted.

"Shucks," Old Sam told them, "when I was a boy, all we could afford was hot dogs and hamburgers. Everybody eats high on the hog these days. At least they eat expensive. Somehow it don't taste the same."

Phoebe said, "Well, we'll be eating a little lower on the hog for a while. I'll have to start doing some of my own baking."

"I wouldn't advise you to sell your Mutual Funds now, Mrs. Perriwinkle," Norman Foxbeater said seriously. "It's a bad market. I'd counsel you to hang on until things bottom out and start upward."

"Well, I'm sure I ought to, Mr. Foxbeater," June Perriwinkle said, "but if the truth be known, I need the money. You see, when I first opened out in the Sentinel Park suburbs, it went, oh fabulously. You can't imagine. But now . . ."

He nodded. "A good many small establishments have a hard time. The first businesses to suffer are the gift shops, the antique shops, the tiny shops that sell Christmas, birthday and get-well cards, that sort of thing. Just what is your business, Mrs. Perriwinkle?"

"Why, I have a little restaurant. Oh, I assure you, only six months ago we were," she fluttered a laugh, "just packing 'em in, as we say in the trade."

She handed him a card. "You and Mrs. Foxbeater must drop by some day. We're never packed any more. It's the *Lovey Dovee Wee Hottee Doggee Shoppee.*"

Mr. Foxbeater suppressed a slight start. "I still think you ought to

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hang onto your Mutual Funds," he told her. "Investing more money in a venture such as this, in these times, is, uh . . ."

"Well, *really!* If the truth be known, I know a bit more about the restaurant business than you might, Mr. Foxbeater. I've been cooking in my own kitchen all my life."

After she had gone, Norman Foxbeater gazed unseeingly into a corner of his office for a long time. Eventually, he sighed and flicked a switch on the office intercom.

He said, "Mortimer, are you occupied?"

The box answered and he got up and went into his partner's office.

Mortimer Foder looked up at his entrance. "Sit down, Norman. You look none too jubilant."

Foxbeater came directly to the point. "Mortimer, I am of the opinion we ought to liquidate."

"Liquidate!"

The younger man nodded. "Get our holdings into gold in Switzerland."

Mortimer Foder stared at him.

Foxbeater said doggedly, "It is not something you can exactly put your finger upon. It is a dozen things. Sometimes I prefer to operate on intuition."

The elderly broker and investment counselor nodded heavily and said, "Very true. However, so-called intuition is usually backed by a few hard facts."

His partner shook his head. "Not very hard, I am afraid, in this case. I was talking to Frank Wesley the other day. You know that development he had planned over near Vandenberg Village? Well, he has given it up. Had some houses he had orders for—well, one or two, at least —canceled. The big one he was doing for Bill Waters of the Buick agency, for example. At any rate, he has canceled the whole project."

Mortimer Foder frowned at him. "Why did Waters give up the house? He seemed quite upbeat about it when I saw him at the Browning party."

The younger man nodded. "That's part of what I mean. I assume the air-cushion car isn't going quite so well this year." He hesitated. "Have you noticed how many of the little shops around town are up for rent or sale?"

Foder's lips moved in and out. He said finally, "Liquidate all our holdings and convert to gold in Switzerland, eh? Afraid of inflation?"

"More, a heavy drop in the market, then possible deflation of the gold content of the dollar. When it is over, we will buy back in, of course. Make a killing. I see signs it has already begun. A number of the smaller investors are selling out. They need the money to support their own little endeavors, or, some of them, for daily expenses. There is a bit of unemployment about town."

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His senior partner was scowling. "But, you know, Norman, I was planning to retire. Turn everything over to you and young Bryant."

Foxbeater shrugged. He said slowly, "You could still do that of course, Mortimer. I'm sure I could handle it."

The other shook his heavy head. "No. Too much of an undertaking. Needs careful supervision. Let me think about it."

Norman Foxbeater slowly came to his feet. "I would suggest a quick decision, Mortimer. You can't be late in this game. When the bottom falls out, it can fall out overnight. There'll be many left holding the bag. And it is their securities we will be buying up for peanuts when the smoke clears."

"If it clears, this time," the old man grumbled.

"I beg your pardon?"

"Nothing," Mortimer Foder said. "I'll talk it over with you and Bryant a bit later, Norman."

"Fine, Mortimer," Foxbeater said.

After the younger partner had left, Mortimer Foder sat for a full hour before finally sighing down to his insteps and reaching out to activate his communicator. He said to the girl who answered, "Miss Ballentine, get me the Seaforth Shipbuilders in Wilmington, California."

A few minutes later, he was saying into his phone screen, "I realize that and am willing to pay whatever penalties will accrue. However, I must definitely cancel the yacht's construction."

Half an hour later, in Wilmington, Peter Fielding was saying to his foreman, "I can't help it, Mike. That's the way the wind blows. We're going to have to shut down all three ways. If we're losing the building of the Foder yacht, I don't want to take a chance on doing the other on spec."

Mike said unhappily, "How about the small job for the movie guy?"

"It's not important enough to keep the yard open. We'll shop it out to Gonzales and Martines."

"Oh, great," Mike said. "And I was considering buying myself a house. The old lady's tired of living in a two-by-four apartment. I'll have to tell that real estate agent, it's no go."

"Sorry, Mike," Fielding said. "It'll be hard on us all, until we get some new orders. I was getting myself a four-place Pipe Mini-Jet. Figured on flying down to Ensenada on weekends for fishing. I'll have to cancel. The Piper representative isn't going to like that, he's already ordered the plane."

The President said, "Craminently, Scott, send in Weigand Dennis, will you?"

"Yes, sir, Mr. President."

The secretary left and shortly afterward the President's press chief entered, deceptively lazy in appearance and attire, as always. A corn-

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cob pipe, his trademark in news circles, hung from the side of his mouth.

"What is it, Chief?" he said.

"Sit down," the President said, and, even before the other had lowered himself into one of the heavy leather chairs, "You find time, easier than I, to keep your ear to the ground. What in the name of Moses is happening in Cleveland? In fact, what's happening everywhere?"

"Why particularly Cleveland?" Dennis said cautiously.

The President waved a report. "We just got this hurry-up call asking for financial assistance to keep their soup kitchens going. What's a soup kitchen?"

Weigand Dennis reached for his tobacco pouch, even as he said, "Actually, not a very good term, under the circumstances. It goes back in time. What's happened in Cleveland is that they have this emergency food program. Those in distress can request free meals from the city."

"Is it that bad in Cleveland?"

"I'm afraid it is, Mr. President. And this project is just too much for them. You see, they tied it in with another program, to come to the relief of some of the delivery services, trucking concerns and so forth that were having a bad time. So instead of having to stand in line, at the soup kitchens, the food is delivered to each home."

"Well, what's the crisis?"

Weigand Dennis was packing his pipe. "Evidently, those on relief rebelled against the diet. Everybody's weight conscious these days. They lit into city hall demanding a low carbohydrate, high protein diet. You know, steak, asparagus, artichokes, avocado that sort of thing. An election was coming up, so the City Fathers capitulated."

For the moment the President was in his own field of understanding. He said, "Well, that makes sense."

Dennis shrugged, searching for matches in several pockets. "Yes, sir. But the city treasury was already low, all taxes and other city income being down. Consequently, they're calling on the Federal government for aid."

"Craminently!" the President snapped. "Don't they realize how much money we're going through as it is? Don't they realize we're liberating Mozambique, containing Finland and conducting a police action in the Antarctic?"

He picked up another report and waved it at the press man. "That's not all. That's not all by a darned shot. What's going on in Denver? They want money, too."

"They ran out of local relief funds and the unemployed drove on city hall."

"Drove on city hall?" the President scowled.

"Yes, sir, in the old days, people with a beef used to march on city hall, carrying banners and so forth. These days they drive."

"Oh." The President remained si-

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lent a while, his face working as though in hard thought.

Which surprised Weigand Dennis. Presidents were not expected to be particularly bright anymore. This one had possibly the best public image, the most appealing Tri-Di personality of all time, besides being photogenic and having an eidetic memory for the names of every person with whom he had ever shaken hands.

"Son," he said finally, "what in the name of Moses is going on in this country?"

Weigand Dennis had got his pipe going, he exhaled the smoke from his mouth and said, "Mr. President, it's a depression."

"A depression?"

"Yes, sir."

"What is a depression?"

Dennis clicked the stem of his pipe against his teeth. "Well, sir, it's been a long time. I've been reading up on the matter the past few days. Checking it out. In the early days they'd call one a Panic or a Bust, but after a time they must've realized it didn't help get out of them by using that sort of terminology so they switched to Depression. Even that had too negative a connotation so after the big one, 1929 to 1939, they called them Recessions. Finally some brain came up with Readjustment or Rolling Readjustment. But we haven't had a real blockbuster since 1939. Before our time, of course."

"But what *is* it?" In sudden irritation the Chief Executive added, "What do you burn in that confounded thing, soft coal?"

Dennis slipped the pipe apologetically into a side pocket. "Well, sir, do you know the term geometric progression?"

The President had been involved in campus politics at the time mathematics were being handed down, but he made a point of never admitting ignorance about anything.

Weigand Dennis understood the expression on his face from of old. He said, "A geometric progression is when you go two-four-sixteen, uh, sixteen times sixteen would be, uh, two hundred fifty-six. And so forth."

His ultimate superior was looking at him blankly.

Dennis shifted in his chair. "Well, sir, a depression is the opposite of that."

The other was still blank.

Weigand Dennis said desperately. "Sir, take Los Angeles. It starts as a small city. Some people come out to retire, liking the weather. They have houses built. The contractors haven't enough construction workers to do the building so they offer premium wages and attract employees from back East. These like the looks of L.A. and decide to remain, which involves building more houses and apartment houses, and stores to supply their needs. This all calls for more materials, cement plants, brickworks.

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It calls for more gasoline stations, more newspapers. More everything. A boom is on. More people arrive to get in on it. Money flows. Bars go up, nightclubs, nice restaurants. Boom begets boom. People making lots of money want luxuries. Car dealers go into business, swank hotels go up to house the businessmen coming to town.

"Little people get into the act, too. They've twenty thousand dollars or so to invest in a small business. Largely, they go into things they don't know anything about. A retired restaurateur starts a chicken farm. A retired farmer opens up a little restaurant specializing in Chinese food; he's a Swede. While they're building their restaurants, or chicken farms, or drive-in Tri-Di theaters, or whatever, they spark the boom still more."

The President said, "Yes, yes."

Weigand Dennis fished his pipe from his pocket unconsciously and then pointed the stem at his superior. "Well, Mr. President, you can probably see it coming. The bust. The depression. Some of these little businesses fold. The empty buildings are up for lease. The construction workers go on unemployment insurance and cut back in their buying. They stop patronizing restaurants, beer joints and Tri-Di theaters. So a lot of these places fold or at least cut down staffs, causing more unemployment. People stop buying new cars. The local agencies cut back or fold. People start leaving town to go back to living on small farms where they can at least grow their own gardens. Meanwhile, Detroit cuts back car production, which means cutbacks in steel and all the other things that go into cars. Detroit lays off a hundred thousand employees or so, and steel lays off the same. The farmers begin getting less call for their products and farm prices skid. The farmers stop buying everything from kitchen appliances to Joy perfume."

"All right, all right. I get the picture. It pyramids backwards."

Dennis flinched at the term but said, "That's about it, Chief."

The President's face worked in thought again, to the fascination of his press officer.

Finally he said, "Why this could be awful. Craminently, it's interfering with my Far-Out Society, the most fabulous society of all history."

Weigand Dennis clicked the stem of his pipe against his teeth. "Yes, sir, it'll do that. And all our aid programs. It's going to be difficult to keep shoveling all that money abroad."

The President said plaintively, "Well, how did they get rid of them in the past?"

Dennis had been afraid he was going to ask that one. He said, "Well, that's a good question. Roosevelt, who inherited the classic of all times, tried various things, most of which the Supreme Court kicked out. Like the NRA which was supposed to mean, National Re-

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covery Act, but which soon meant to most businessmen, Never Roosevelt Again. Then he figured on sending prices up by shooting pigs in the Middle West and pouring kerosene on potatoes up in Maine. He put all the juvenile delinquents into the CCC where he paid them to range around the woods supposedly planting trees and so forth. Then he brought back beer."

"Brought back beer?"

His press chief suppressed another wince. "He'd inherited Prohibition. But, of course, all that great experiment did was put the booze income into the pockets of the boys, such as Al Capone. The government needed the taxes, so they brought back first beer and then liquor. That, of course, threw a lot of honest bootleggers out of work and they started robbing banks and kidnapping the few remaining citizens who had any money."

The President stared at him. "He sounds drivel-happy."

"Well, yes, sir. At the time, a lot of people thought so. But, on the other hand, some thought him the greatest politician ever to come down the pike."

"Oh, they did, eh?" The President went through his thought processes. "I suppose there's a lot of political popularity to be won by a President who gets the nation out of a hole like this."

"Yes, sir. I suppose there is. Roosevelt was reelected three or four times."

"Three or four times? That's illegal!"

"Roosevelt was pretty popular. He wowed them out in California by paying the farmers to chop down their fruit trees."

The President was wide eyed. "What did that accomplish?"

"Well, sir, it evidently made sense to Roosevelt and his brain trust. They wanted to send the price of fruit up. It seems as though there were some fifteen million unemployed and a lot of people hungry and . . ."

The President held up a hand. "Hold it, Weigand, you've lost me already. What was this about a brain trust?"

When Marv Sellers returned home after sitting around with the others at the union hall, he was surprised to find Phoebe there. He looked at his watch, then remembered that it had stopped and that he hadn't wanted to spend the money for repairs.

Phoebe made her mouth into a bitter moue. "Fired," she said.

He looked at her in dismay.

She said, "The company's big item here in Tucson was distributing all these gadgets. You know, nuclear back scratchers, electric toothbrushes, that sort of thing. Evidently, people finally got around to the fact that they could do without them. So the company folded. Even Mr. Edwards has gone on relief."

"Oh great," Marv groaned. "Now

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we're both unemployed, and all our payments coming up."

Phoebe said, "Look, Marv, we can sell the car. It's only a year and a half old and nearly paid for. We'll get several thousand dollars for it."

"Oh, yeah? You oughta see the used cars on the lots. Piles of them."

"We won't sell through a dealer, we'll put an ad in the paper."

He said, "What'll we do without a car? I need it to get to work . . . if I get a job."

Old Sam had come in. He chuckled, almost happily, "Gettin' to be like old times," he said. "I used to ride to work on a bike, when I was a kid. More fun than a car."

"Knock it, Gramps," Marv growled.

Bill Waters flicked off his phone screen and turned to his secretary. "Miss Harding."

"Yes, sir."

"That was old man Benington canceling the only order we've had for over a month."

She looked distressed.

Waters said, "He bought a used car from some bricklayer who sold it for less than half price. How can I compete with that sort of thing?"

"I don't know, Mr. Waters. I . . . I heard the new models aren't going to have any chrome at all. Bring down the price."

"That's right," he grunted. "Which has precipitated a crisis in the chrome industry. They've laid off five thousand men."

He came to a sudden decision.

"Well, that's the straw that broke the back. Notify the men out in the shop that I'm closing."

She looked both distressed and sympathetic. "The usual two weeks severance pay, Mr. Waters?"

He laughed bitterly. "Where do you think I'd get it, Miss Harding? My father-in-law's offered me a job as delivery boy for his delicatessen. He's fired the two he used to have. Wants to keep the job in the family."

The President was having another of his meetings with his brain trust. Weigand Dennis sat immediately to his left and a bit behind him. The professors, economists, sociologists and psychologists sat about in a circle, dimly reminiscent of King Arthur and his Round Table.

The President had on his Tri-Di personality—to begin with. He said brightly, "All right, Professor."

Weigand Dennis leaned forward and began to whisper, "Leland Markham, Harvard . . ." but the President muttered, "I know, I know. I never forget the face of a potential voter."

Professor Markham shuffled his papers in full stereotype.

He said, a hurt quality in his voice, "Our road-building program didn't exactly turn out the way we thought, Mr. President."

The President scowled. "Why not? It was a natural. Put men to

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work all over the country building the roads, mining the needed material, asphalt, cement, everything."

The professor cleared his throat apologetically. "Yes, sir. It was all right as long as we were *building* the roads on a crash basis. It is what happened afterwards we didn't anticipate." He cleared his throat again. "The fact is, these newer, wider, faster, straighter roads enabled the truck companies to move freight faster and hence with fewer men and trucks. Since the roads are so straight and strong, it enabled them to use larger trucks. Now fewer drivers are needed, and since there are fewer trucks, less mechanics. Besides that, the competition has crowded out various railroads and resulted in the remaining cutting down of their daily freight car loadings. The long term result has been greater unemployment."

The President groaned softly.

"I'll never end this and get my Far-Out Society underway," he complained. He turned to his next authority. "Well, Doctor?"

The other expressed discomfort. "I'm afraid my report has similarities to Professor Markham's."

The President turned off what remained of his Tri-Di personality and said coldly, "You were pretty happy about it."

"Well, yes, Mr. President. As a temporary make-work project building the dams employed tens of thousands."

"What could possibly go wrong?"

"Well, when the dams were completed they opened up wide areas of former desert to agriculture. As you know, given water, desert areas can prove fabulously fertile. Also these areas were so flat they particularly lent themselves to automated farming." The doctor shook his head mournfully. "There's been a double result. We're producing more farm products than ever, but at the same time the smaller farmers are being driven to the wall because they can't compete."

The President closed his eyes for a moment in pain.

"Anything else?" he demanded before opening them again.

"Well, yes, Mr. President. There was another side effect. The new dams, with the very latest hydroelectric generating equipment, have released so much additional power that several projected nuclear power plants in those areas have been canceled. At this stage, they couldn't compete with water power. It has" —he hesitated before breaking the news—"led to the dismissal of several thousands of construction and nuclear power workers."

"Craminently," the President complained. He looked about his round table. "Does anybody have any *good* news?"

Somebody rustled papers and said meekly, "I have a report here that the Bull Durham Company is booming."

"Bull Durham?" the President said blankly.

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Weigand Dennis leaned forward. "A roll-your-own cigarette company, Chief. The, ah, tailor-made cigarette companies aren't doing so good. Neither are liquor companies. With taxes so high, everybody's making bathtub gin and home-brew."

One cheerfully faced type chirped, "Well! here's one from the plus side. We've finally got every man jack of the military forces back home, and most of them out of uniform. It will cut literally billions from our expenditures and free the money for use to fight the depression."

A Yale economist moaned.

A secretary said, apologetically, "There's a side development to this, Mr. President."

Everybody looked at him. He said, unhappily, "The veterans. They're forming organizations. One is demanding free tickets on the airlines. First-class tickets, with meals. To march on Washington so they can demand a bonus."

A feisty, bearded type from across the table snapped, "There is one matter I think must come to your attention, Mr. President. When we raised tariffs so that foreign commodities wouldn't flood our few remaining domestic markets, we put Common Europe and the rest of the world into a tizzy. They raised tariffs, too, and our exports have fallen to the vanishing point."

"Well, then at least it balances off even," the President grumbled.

"Not exactly, Mr. President. You see, our economy depends upon the import of copper from Chili, oil and iron ore from Venezuela, tin from Bolivia, and so forth. As a result, we've been spending money abroad consistently, but not making any by exports. Our gold is flowing away from Fort Knox as though there were a leak in the vaults." The feisty one ventured a sour laugh.

Nobody joined him.

The President looked over his shoulder at Weigand Dennis and muttered, "So this is a Brain Trust."

Marv and Phoebe Sellers sat at the kitchen table of their house at 4011 Camino de Palmas, Tucson, Arizona.

Marv looked around at their packed belongings bitterly.

"Dave oughta be here with his truck, pretty soon," he said. "You sure your folks don't mind us moving in with them?"

Phoebe shrugged resignation. "I suppose they mind, Marv. But what can they do? It's happening all around town. People moving in with each other, to save rent. How long do you think it'll take to sell the house?"

"I don't know, Phoebe. Houses aren't moving any too good."

"What do you think we'll get for it, Marv?"

"Not very much, we ain't got much equity into it. Payments for five or six years. Where's Old Sam?"

"He's in the next room, messing

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around in some of that old junk he had stored away in a trunk in the garage. What're we gonna do, Marv?"

He shrugged his depression. "I don't know, Phoebe. Just go on relief like everybody else, I guess. What else?"

"I heard the city was cutting back on relief. They run out of money. They ain't even paying the teachers any more."

Old Sam came in chortling.

"What've you got there, Gramps," Marv said disinterestedly.

"You'll see," the oldster chuckled. He had a big piece of cardboard in one hand, a box of crayons in the other. He laid the cardboard out on the table, selected a crayon and began to color in a big black zero.

Marv, frowning, got up and looked over his shoulder. He read slowly, *"Unemployed. Please Buy an Apple. 50¢"*

Old Sam chortled again. "You young people never listen to me when I tell you about the old days. You'll see. I'll make us some pocket money."

Marv said accusingly, "That sign used to read 5¢. How come you're upping it to 50¢?"

"Inflation," Old Sam said cryptically. "Found this sign in the bottom of my trunk. Kind of forgot about it. You stand out on the street corner with a box of apples and this sign. Mint money."

"I'll bet, Gramps," Marv muttered.

The President was slumped in his chair at his brain trust round table, after still another disastrous conference. The only ones left were his secretary, Scott, and Weigand Dennis.

"Double-domes," he said in complaint. "Craminently. First one wants to cut back government expenditures by firing half the bureaucracy. That puts near onto ten more million people on unemployment. Another one wants to bring up prices, something like Roosevelt did, by plowing under cotton, that sort of thing. But this depression is *really* big. This time, they want to pour petroleum back into the wells, and shovel coal back into the mines."

Scott and Dennis held their peace.

The President mumbled, "But that one from Princeton's right. We've got to save money some way. Fort Knox is practically empty."

His face brightened. "There's one thing. Scott, relay orders to discontinue the Space program. Can't afford to be shooting all that curd up into the sky. If they won't allow me to liberate Mozambique and contain Finland, I don't see how we can afford to colonize the moon."

"Yes, Mr. President," Scott said. "The base on the moon. How about the men in that?"

"How many of them are there?"

"Eight, altogether."

"How much will it cost to bring them back?"

Scott looked blank.

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Weigand Dennis clicked his pipe stem against his teeth unhappily. "I'd estimate about a billion dollars, Chief."

Weigand lit his pipe. "Sets an example, sir," he said. "Johnson used to turn out the lights."

The President looked at him balefully. "What do you smoke in that thing, shredded army blanket?"

Weigand Dennis sighed and put the corncob away.

"Leave them there. They're expendable," the President said grimly. "Raise a big monument to them. It'll be cheaper."

He scratched himself. "This heavy underwear the Missus has me in sure itches. You'd think that cutting down on the burning of oil would be something unnecessary in the White House."

The President snorted. "What do you think about this reopening relationships with Cuba?"

"Well, it has its points, sir. Keep the unemployed a bit more tranquil. Back when times were booming, everybody was in a hurry and smoked cigarettes. Now that everybody's sitting around, watching Tri-Di they've got time for a long smoke. Some people are pretty serious about that slogan: What this country needs is a good fifty-cent cigar."

The President grunted. "Talking about slogans, what do you think about that one proposed by Professor Markham to keep up morale? Prosperity Is Just Around the Corner."

Dennis said thoughtfully, "I think I've heard that somewhere before. My instinct is to believe it won't be well received by the older generations."

The President glared at him. "Confound it, Weigand, why don't *you* come up with something? You're supposed to be my whizz-bang adviser."

Weigand Dennis stirred in his chair. "To tell the truth, Mr. President, I think I have the germ of an idea."

"Well, in the name of Moses, what is it? I've been listening to drivel for the past four hours, a little more can't hurt."

Dennis nodded and absently reached for pipe and tobacco pouch.

"Sir, remember when I was telling you how a depression got started? The slow start, and then the snowball effect. Just like boom begets boom, bust begets bust?"

"How could I forget! It was the first time I ever heard of a depression."

"Yes, sir. Well, it occurred to me that *somewhere* this depression had to start. Some single place in the country. Some single action." He paused for effect.

The President was staring at him, a glimmering of hope far behind his eyes. "So!"

Dennis shrugged his lazy shrug again, and lit the corncob. "So suppose we trace it down. Suppose we get to this root of the evil. This starting point."

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The President still stared. His voice was slightly hoarse.

"Then what do we do?"

Weigand Dennis replaced the tobacco pouch in his right jerkin pocket, the matches in his left. He blew smoke from his nostrils.

"We play it by ear," he said.

Weigand Dennis took in the long rows of computers, the clacking sorters and tabulators, the collators and key punches.

He shook his head and said, "Let's get out of this noise."

The other led him to an office. The door that closed behind them was soundproofed.

"Holy Smoke," Dennis said, "how do you do any thinking in that?"

"We don't have to do any thinking," Rod Watson told him. "The machines do the thinking."

Weigand Dennis looked at him, even while fumbling in his jerkin pocket for his pipe.

Watson said, "And after they've done their thinking, we bring the result into offices like this and think about what they thought about."

"Very funny," Dennis said. "I'll tell the President how this department produces jollies."

Rod Watson blanched.

Dennis said, "O.K., O.K. I won't really. He's on a retrenchment binge these days. Bring down expenses. Let go some of the millions of governmental employees that've been pyramiding ever since Hoover. He fired the Air Force yesterday."

"Fired the Air Force?" Watson said.

"That's right. What do you need an Air Force for with all the missiles we've got? At any rate, how far did you get today?"

Rod Watson walked around to the other side of his desk, sat down and selected a report. "Detroit," he said. "According to the computers, the beginning of the big crackup was when Detroit cut back production and laid off about a hundred thousand men. That's when it really started snowballing."

Dennis was lighting his pipe. He shook his head wearily.

"No," he said. "You don't understand what I want from you, Watson. That wasn't when it started snowballing. By that time, the avalanche was well under way."

Watson was scowling at him.

Dennis pointed with his pipe stem at the second button on the other jerkin. "*Why* did Detroit cut back?"

Watson blinked. "Why? Why, isn't that obvious? The new model cars weren't selling."

"Why? Take it further back."

Rod Watson looked distressed. "See here, Mr. Dennis, the Bureau of Statistics isn't omniscient."

Weigand Dennis puffed gently on his corncob. "Then it better get that way. Don't forget the Air Force, Rod, old man."

Watson closed his eyes in anguish.

"Just what is it you want, Mr. Dennis?"

"Go further back." Weigand Den-

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nis waved vaguely in the direction of the machines room. "Somewhere in all that accumulated data in there, you can find the *beginning* of it all. That first single grain of sand that started down the mountainside, jogging other grains, then pebbles, then rocks, until finally the avalanche was on us."

Watson groaned.

Weigand Dennis, flanked by two cold-eyed Secret Service men, came up the cement walk, taking in from the side of his eyes the unkempt condition of the lawn. It wasn't just the lawn. The house could have used a coat of paint—or two. One of the shutters was hanging from a single hinge. There was a newspaper stuffed in a broken window.

Dennis grunted. "Place looks better than most, these days."

The others said nothing.

He mounted the wooden steps, which creaked forbiddingly, and knocked on the front door, assuming, without trying, that the bell would be out of order.

An elderly woman peered out at them. She looked like every other elderly woman he had ever seen, all combined. She would have had no trouble getting an extra's job as an old lady, in any Tri-Di production Hollywood made. Had Hollywood been making any Tri-Di shows these days. Who could afford to advertise on Tri-Di anymore?

Weigand Dennis said politely, "Is this where Marvin Sellers lives?"

She said immediately, "If you're bill collectors . . ."

"We know, we know. Mr. Sellers couldn't pay if we were. We're not."

"You can't get blood out of a turnip," she said.

"A very apt phrase you've coined," he bowed gently.

She turned and yelled over her shoulder, "Marv! You Marv!" and then disappeared.

Marv came to the door and looked at them in suspicion.

"Yeah?"

Weigand Dennis looked at the other for a long moment.

"So you're the one who started all this," he murmured.

"What?" Marv said suspiciously.

Weigand Dennis said, "Can I talk to you privately?"

"Well, I don't know. Why? I guess so. Come on in." He held the broken-screened door open. "In here's the parlor."

Weigand Dennis and the two Secret Service men followed the bricklayer into the Victorian period living room.

Marv Sellers said, "Sit down, gents. What's all this about?"

Weigand Dennis said tightly, "Boys, this talk has to be absolutely private."

Guns flowed into the hands of the two ultra-trained operatives. One stationed himself at the window, staring out, empty of eye. The other stood at the door, opened the slightest of cracks so that he could see into the hall beyond.

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"Hey, what the hell's going on?" Marv Sellers protested.

The two Secret Service men ignored him.

"Sit down, Mr. Sellers," Dennis said soothingly, as he reached for his pipe. "I'm a special representative from the President." He brought forth credentials, handed them to the other, and then fumbled for his tobacco pouch.

"Special representative from the President? You mean of the United States?"

"That is correct, Mr. Sellers." Dennis got his pipe going, then brought forth another sheaf of papers. He checked through them, found what he wanted.

"Mr. Sellers, two years ago, on Saturday, May 12th you phoned the Withers Appliances Shop and told them to come get a new deepfreeze you had bought shortly before. Mr. Sellers, that action on your part precipitated the current economic slump."

Marv Sellers bug-eyed him. "Who, me?"

"That is correct." Dennis held up a hand. "Yes, yes, I know what you are thinking. That many people send back appliances, cars, every other commodity. And usually this is simply a part of the workings of the economy, part of the give and take of the everyday business scene. However, private enterprise, as a socioeconomic system, is a sensitive mechanism. Evidently, ours had been running at a delicate balance. It was your individual unpremeditated act that unleashed tiny forces that became larger forces and still larger, finally leading to the utter collapse of our economy."

Marv Sellers thought about it, round eyed. "Wow. I'm surprised the President didn't send the FBI after me."

Dennis said soothingly, "He couldn't have even had he wanted to, Mr. Sellers. He let the FBI go last week as part of the government retrenchment. There are no longer any bank robbers, there's nothing left in the banks to rob, and the Communists are no longer desirous of taking over the country."

Marv spread his hands. "Well, all I can say is, I'm sorry. There's nothing I can do about it. Here I am, living with my wife's people. No job. Flat broke."

Weigand Dennis was nodding. "It's a top secret, last ditch try. Back in Washington, we've dubbed it Project Sellers. We're up against the wall, Mr. Sellers. Half of the Senate is already in favor of giving the country back to the Indians. But the tribes still remaining are cagey."

"Project Sellers?" Marv blurted.

"Correct." Weigand Dennis turned his eyes to the Secret Service man at the window. "Steve, let me have that envelope."

"Yes, sir." Steve took out a long envelope from his inner jerkin pocket, brought it over to Dennis and then returned to the window and his guard duties.

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Dennis said, "Remember, this is top-most security. Highest priority. Everything would immediately be ruined if it got out. It all must be spontaneous. Not even your wife must know, Mr. Sellers." He handed over the envelope.

"Phoebe? I can't tell Phoebe?"

"Absolutely no one."

Marv Sellers hesitated, but then, as though snake-fascinated, slowly opened the envelope.

And brought forth a thick sheaf of spanking new banknotes.

"What's this?" he said.

"Obviously, money."

Sellers chuckled bitterly. "U.S. government money?"

Dennis said, "I know, I know. However, there are still sixteen pounds of gold in Fort Knox. This money has been issued based on that."

Sellers was round-eyeing him again.

Dennis said hurriedly, "And there'll be more when you've spent that. The President is arranging for a loan from Monaco. It seems that the present Prince of that country has a soft spot for America. His mother was an American, or something."

"All right," Sellers said. "I'm as patriotic as the next one. What do I do?"

Phoebe and Marv Sellers and Old Sam moved back into the house on Camino de Palmas the following day. It had never sold, anyway.

Marv was admirably stubborn. He had a government job. He'd tell Phoebe and Old Sam nothing more than that.

The same day, he phoned Barry Benington.

"Mr. Benington," he said. "I've had a change of mind."

"Change of mind? What's that, what's that?" the old man wheezed.

"That car I sold you. You know, I liked that car. I'd like to buy it back."

The old man turned sly. "Why, I don't know about that, Mr. Sellers. I've rather taken to it myself."

Marv said cautiously, "I'd be willing to pay you five hundred more than you gave me for the old wreck."

"Five hundred? Well, I don't know. I've had her polished up, you know, spent a lot of money on that beautiful car."

"I'll make it a thousand," Marv said.

"It's a deal!" the oldster wheezed quickly.

That afternoon when Bill Waters came up on his bicycle to deliver some bologna and cheese to old man Benington, the other met him at the kitchen door.

Benington wheezed, "Bill, what's the price of one of them Buick Cayuses?"

Bill Waters looked at him. "I thought you bought yourself a used car, Mr. Benington."

"Yeah, but I'm tired of it. Sold it back. I always did kinda hanker af-

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ter one of them air-cushion cars. Can you still get me one?"

Bill Waters felt a tremor. He said, trying to keep his voice even, "Well, I sort of closed up my place. But, come to think of it, I guess I've still got the franchise. I could certainly order one from the distributor in Denver."

"Now, you do that for me, Bill. I've got the cash money right here for a down payment."

Marv Sellers was saying to Jim Withers, "Yep, what we need is one of them new deepfreezes. Phoebe wants one of them cerise models."

Withers was taken aback. "You got the down payment, Mr. Sellers?"

"Thought I'd just pay cash."

"I can sure as hell order you one. We don't have any in stock. The shop's closed."

"That's all right. I'll pay you now. And look, Jim. The other day, I was reading about a nuclear Martini stirrer. Has a little atomic pack in it, like. Stir your Martinis for twenty years, before running down. Now a gadget like that . . ."

Jim Withers said quickly, "I know where I can order you one. I'll get several of them. You know, it's about time I opened up that shop of mine again."

"Sure is," Marv said.

When Norman Foxbeater drove past the *Lovey Dovee Wee Hottee Doggee Shoppee* he was mildly surprised to find the place hadn't folded its doors. In fact, it seemed to be having quite a play.

Whatever brought him to enter, he couldn't say. Possibly it was because it was so unusual to see even mild business.

He sat in a booth and allowed the waitress to bring him a dish of very small weiners, a portion of baked beans and some potato salad. The baked beans were fabulous. He dimly remembered Mrs. Perriwinkle bragging about her home cooking.

He recognized a few of the faces. Over there was a bricklayer who had once worked briefly for Foxbeater in the building of a backyard barbecue. What was his name? Sellers or something. And over there was Barry Benington, who'd once had an account with Foxbeater & Foder. And on the other side of the room was Bill Waters and his wife. When times had been better, Bill had belonged to the country club. Foxbeater nodded to him and received a cheerful wave in return.

Hm-m-m. Things were evidently looking up for Bill Waters.

Mrs. Perriwinkle came sailing by, all smiles, a dish of her tiny hot dogs in hand.

She recognized him and stopped.

Foxbeater said, "You seem to be doing quite a business, Mrs. Perriwinkle."

"Oh," she lied airily, "it's always like this. If the truth be known, one of these days I'll be dropping by to put some of my earnings back into Mutual Funds." She swept on.

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He looked after her.

An hour later he came into Mortimer Foder's office.

"Mortimer," he said thoughtfully, "my instinct tells me it's time to pull that money out of Switzerland and invest in American securities."

His senior partner looked up at him. "Oh? Well, good. Get this all ironed out and I'll be able to retire. I'll bet I can get a yacht built for a pittance these days."

"Hm-m-m," Foxbeater nodded. "But don't put it off too long. Get your order in while things are slow."

They were seated around the kitchen table.

Phoebe said, "Guess what? Mr. Edwards wants me to come back to work. They've got a whole batch of new gadgets they're going to market."

Marv said, "Oh? Such as what?"

"Oh, a whole lot of things. When everybody was out of work a lot of these technicians and inventors didn't have anything else to do so they kind of puttered around in their cellar and garage workshops and laboratories and came up with just about everything. Like the electric spoons. There's a little stud on the side. You can switch it all the way over from stirring your coffee to eating soup."

Marv said, "Well, I've got good news, too. Heard from my old boss. He's going to be constructing a new factory. Place where they'll be manufacturing air-cushion roller skates."

Old Sam groaned. "Back to the rat race," he said. "I knew it wouldn't last. They ain't making them like they used to. In the old days, a depression was good to last for nigh onta ten years."

"Knock it off, Gramps," Marv growled at him.

The old boy came to his feet. "I better put away that apple sign of mine. I'll bet the next one will be a doozy."

"Yes, sir," Weigand Dennis said, with satisfaction. "It worked."

The President was jubilant.

He rubbed his hands together. He chortled, "Now we can get back to my Far-Out Society. And we can get that police action down in the Antarctic going again. Scott, get me Admiral Pennigton on the phone. We're going to take him out of mothballs. And instruct the Octagon to discontinue melting down the Fifteenth Fleet."

"Yes, Mr. President," Scott said.

The President added thoughtfully, "I wonder how those boys up on the moon are doing." ■

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the reference library

P. Schuyler Miller

IN DEFENSE OF STORIES

The first generation of science-fiction writers were brought up on a tradition of Nineteenth Century literature in which strong and complicated plots had not become unfashionable. Those whose formal indoctrination into the standards of literature ended with high school probably advanced no further than Robert Louis Stevenson. (Those who were in technical or scientific courses in college got precious little updating: there was rarely time for academic work.)

Most of these people developed their own reading tastes and discovered the contemporary fiction of their time entirely on their own. Generally speaking, they were—and are—catholic and omnivorous readers, and in their day people still read for enjoyment instead of watching TV commercials. (Nowadays the place to find big newsstands is in small towns with poor TV reception.) All-fiction magazines crowded every newsstand, and printing costs had not risen so high that they could not be published at a price most readers could afford.

These magazines told stories; the better ones told them well. The plotless vignette, the cross-section of meaningless conversation (whose meaning is that it is meaningless—like the world), were gaining status in the literary magazines, but they—we—didn't read many of them. So science fiction grew up as part of the story-telling trade, and for my money should stay there, building on its foundation instead of demolishing it. It is consequently gratifying to find that a writer with some literary status, the late C. S. Lewis, agrees.

"Of Other Worlds" (Harcourt, Brace & World, New York; 1967; 148 pp.; $3.95) is a collection of essays and stories by the author of the memorable trilogy, "Out of the Silent Planet," "Perelandra" and "That Hideous Strength." (A fourth book, never published, came between the first two, we learn from the introduction by a colleague.) It includes one essay "On

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Science Fiction," the complete taped conversation with Brian Aldiss and Kingsley Amis—reprinted by Amis and Robert Conquest in their "Spectrum 4" anthology two years ago—and three short science-fiction stories: "The Shoddy Lands," a disturbing moment of telepathy; "Ministering Angels," in which an aging whore and a righteous do-gooder are sent to take care of the sex-starved males on Mars; and the hitherto unpublished "Form of Things Unknown," which transplants Greek legend to the Moon as reality. There is also a fragment of an unfinished novel about the aftermath of the Trojan War, when Menelaus realizes that Helen is now middle-aged—and that *she* is queen of Sparta, and he merely her consort.

The essays are Lewis's defense of storytelling: the long opening one "On Stories," a series of four on fairy stories—in the sense of Tolkien's similar essay—and writing for children, one "On Criticism," one "On Science Fiction," and a reply to J.B.S. Haldane's attack—not included—on the "Silent Planet" trilogy.

Perhaps the most important point that Professor Lewis makes in his essay "On Stories" is that there are two totally different ways of enjoying books read "for the story." Sometimes the same book may be read both ways; sometimes the writer restricts himself to one or the other audience. One type of reader seeks excitement—suspense, danger, intricate plot and counterplot, all-powerful villains to be overcome. The other wants the creation of a strange and wonderful world that he can explore at his leisure.

This second kind of story quality is what Lewis savored in the books enjoyed most. It is what he tried to put into his own stories, both the children's adventures of the "Narnia" series and the "Silent Planet" trilogy. Later, and in other essays in the book, he emphasizes that he was not trying to write allegories, not trying to express religious verities, not trying to do any more than create strange worlds in good stories which naturally and incidentally involved the other ideas and values which he held important. This quality is what makes Andre Norton's quite simple juvenile books so rewarding for readers of any age; it is the thing that Avram Davidson and Cordwainer Smith and all the best of the present writers do so well. But, if the writer merely uses a framework of excitement on which to hang an idea, as so much science fiction does—including, Lewis feels, Wells' "War of the Worlds"—he limits his audience and his achievement.

"On Science Fiction," a shorter essay, offers some categories that we will all recognize. Of the field as a whole, he says, "it began to be popular when it least deserved popularity, and to excite critical con-

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tempt as soon as it ceased to be wholly contemptible." Most of the "serious" articles about science fiction, he charges, have been written by people who neither like nor understand it and often do not read it. None of the critics was willing to evaluate the stories as stories.

Lewis's first "subspecies" of science fiction—which he considers "radically bad"—is the formula story set on an exotic world or in an exotic future simply to provide a colorful stage setting. (This is the formula of the current spate of save-the-world spy stories, and the reason I pay no attention to them here.) "Whatever in a work of art is not used, is doing harm," Lewis says. The reader he described in his first essay, who wants only excitement, sees no shortcoming.

Subspecies Two is the "Engineers story"—what I call the documentary approach of Arthur Clarke and much of Verne. Number Three is the story of scientific speculation —what's it like out there? It is limited, Lewis points out, by our finally discovering what it *is* like out there. "First man in orbit" stories are dead.

Type Four Lewis calls the eschatological story—Wells' "Time Machine"; Stapledon's "Last and First Men"; Clarke's "Childhood's End"; Hodgson's "The Night Land." This form of science fiction, he points out, can entirely separate itself from the ordinary novel—notably in Stapledon's book.

Professor Lewis's final category, his favorite, and the one used in his own books, is the borderland between science and fantasy. John Campbell has, of course, insisted that his writers explore it. Simplified, the philosophy behind such stories is that anything that exists is grist for "real" science fiction. If you accept the existence of ghosts or flying saucers, you can write rational science fiction about them. If you deny that they exist, you have to treat them as fantasy.

Because these essays have been culled from several places and assembled after the author's death, with no possibility of revising or relating them, there is a good deal of repetition in the book. No matter. I think you'll find it good reading.

NYCON 3

With a discouraging lack of initiative, the committee for Nycon 3, the 25th World Science Fiction Convention, has done nothing as of March 1st to provide me with information on their convention. It will be held Labor Day weekend as usual—September 1st through the 4th—at the Statler-Hilton Hotel in New York City. Lester del Rey is Guest of Honor—a spot long overdue. A membership fee of $3.00, sent to "Nycon 3, Box 367, Gracie Square Station, New York, N.Y. 10028," will doubtless bring you further details in a series of progress reports. For this information I am indebted to the Bulletin of the

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Science Fiction Writers of America and to *Science Fiction Times,* which were in the same mail.

SF Times lists several other regional and local conferences. I am afraid it is already too late to remind you of the Midwestcon, (June 23-25) and the 20th Westercon (July 1-4). But, if you're likely to be in Berlin on August 4-7, by all means make a point of attending German fandom's annual convention. Contact: Reinhard Horschberger, 1 Berlin 12, Schlueterstrasse 49, Germany.

THE REFERENCE FOR OUTSTANDING UFO SIGHTING REPORTS

UFO Information Retrieval Center, Inc., P.O. Box 57, Riderwood, Maryland 21139 • Spiral bound • 150 pages; 30 illustrations; bibliography; questionnaire • 1966 • $5.95

Whatever your personal beliefs about UFO's, I would expect any reader of Analog to welcome a more or less agreed-upon body of data on the sightings that most students of the things consider "outstanding." This compilation of one hundred sixty sighting reports is intended to provide that.

Thomas M. Olsen, UFOIRC Director and editor of the book, doubtless aided by other members of the organization, reports in an introduction that the accounts used have been screened and the original versions used wherever possible. A numerical reliability index has been used, and indices for the reports are listed—chronologically, as are the reports—in a separate section.

You have first, a chronological index to the sightings covered by the compendium, including date, location, source of the information, and number of witnesses. The earliest is 1947, the latest 1964. The detailed reports follow, amply illustrated with maps and drawings —none of the controversial photographs. Then the reliability indices; then a bibliography; and finally a copy of the U.S. Air Force questionnaire used to collect data on sightings.

I am sure other UFO organizations will object because some sightings are included and others aren't. I can't pretend to say whether the accounts are "authentic": the references are given so if you object to any of them, go check the source.

It's a good job. It should clear the air. We should have had it earlier.

WHO CAN REPLACE A MAN?

By Brian W. Aldiss • Harcourt, Brace & World, New York • 1966 • 253 pp. • $4.50

Not so many years ago Brian Aldiss was the Great New English Talent that was putting American writers to shame. Now we have John Brunner, also the highly controversial stylist J. G. Ballard, and there are others coming up to keep them company as there are in the United States. Aldiss has been devoting himself mainly to novels—

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at least, as seen from west of the Atlantic. This collection of thirteen stories drawn from his earlier books and from a few other places thoroughly confirms the talent: he calls it an anniversary collection of the best from his first ten years of writing.

Because most of the stories have been in previous collections, in England if not in the United States —they are mainly from "Space, Time and Nathaniel," "Canopy of Time" and "Airs of Earth"—and the best have been anthologized, many will be familiar. They are still good.

The title story chronicles the transition of a group of higher-grade machines from unthinking automation toward independence, in a world from which the last men have disappeared. "Poor Little Warrior!" is the highly stylized story of a time traveler out to shoot a brontosaurus—Ballard before Ballard. "Old Hundredth" is perhaps the strangest of the lot, and even more in the Ballard vein or even the thread of Cordwainer Smith, with its animal people leading an utterly strange life on an utterly strange future Earth and dissolving into music. It's a story that haunts you.

"A Kind of Artistry" is another strange one from a Smithian future where the evolved remnants of Mankind live out bizarre ritualistic lives on far-flung worlds and a traditional hero leaves his mother/wife/scientist to invade and rob the monstrous entity known as The Cliff. (This story could, I feel sure, be fitted into Smith's worlds without conflict of mood.) And "Man On Bridge" projects another future in which mediocrity is the norm, the Cerebrals are in work camps feeding on their own innate dissent, and one of them has altered a poor clod into a human robot.

In other stories Aldiss shows that he can do conventional stories in a conventional way, and still excel. "Outside" is a gimmick story and a problem story: who, among a caged group, is the alien masquerading as a man? "Basis for Negotiation," which may have been written during the "Ban the Bomb" marches in England, is a kind of capsule "Dr. Strangelove" or "Fail Safe" with a twist of viewpoint and values. "The Impossible Star" is an astronomical freak story, and "Ahead" might have been called "The Impossible Future," with its Failed Men.

The rest are slight, and all different. "Not for an Age": a breakdown tosses the subject/victim of a "chronoarcheological" exploitation into the very future from which gawpers have been watching a day in his life, lived over and over. "Psyclops" is a tour-de-force of telepathic communication between a spaceman and his unborn child. "Dumb Show" is another Ballardesque nightmare of distorted relationships between children and oldsters. "The New Father Christmas"

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is an ugly foretaste of a world where remnants of humanity try to live in a machine world. And "Man In His Time" describes the life of a man temporally displaced from the time experienced by those in the normal world—perhaps I should have listed it as a "conventional" gimmick yarn.

In his taped conversation with Kingsley Amis and the late Professor C. S. Lewis, included in the recent collection of Lewis's essays and stories, "Of Other Worlds," Aldiss says of science fiction: "There's a sense in which you're conquering a fresh country." In this book he explores thirteen fresh countries.

THE REPRINTS AND REISSUES

THE SWORD OF RHIANNON

By Leigh Brackett • Ace Books, New York • No. F-422 • 128 pp. • 40¢

Reissue—I think with a new cover—of one of the best of the old *Planet Stories* school of colorful adventure, this time on Mars of a million years ago.

THE LEGION OF SPACE

By Jack Williamson • Pyramid Books, New York • No. X-1576 • 189 pp. • 60¢

Pb edition of one of the remembered space operas from the old good old days: here in 1935, no less. It's notable chiefly for the Falstaff of science fiction, Giles Habibula.

NEEDLE

By Hal Clement • Avon Books, New York • No. S-255 • 207 pp. • 60¢

New pb edition of Hal Clement's most popular—though not his best—book, serialized in Astounding in 1949. A galactic criminal and his pursuer hide in the bodies of two people here on Earth.

MAROONED ON MARS

By Lester del Rey • Paperback Library, New York • No. 52-415 • 158 pp. • 50¢

Pb edition of one of the Winston juveniles.

THE GENETIC GENERAL

By Gordon R. Dickson • Ace Books, New York • No. F-426 • 159 pp. • 40¢

NO ROOM FOR MAN

By Gordon Dickson • Macfadden Books, New York • No. 50-329 • 158 pp. • 50¢

Reissues of two of the novels in the author's long cycle of books covering mankind's future. "The Genetic General" was serialized here as "Dorsai." The Macfadden book was published as "Necromancer."

THE VALLEY OF CREATION

By Edmond Hamilton • Lancer Books, New York • No. 73-577 • 159 pp. • 60¢

Reissue of a fast-moving "lost race" story by a man who can make 'em move.

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brass tacks

Dear Mr. Campbell:

Editorial: Too true to call for much comment. Wonder why our leaders have never pointed out that those terrible "Yankee imperialists" are actually fighting against *Communist* imperialism? (*Not* against "Communism"; there are no American troops in Yugoslavia.)

And I wonder something else: What happens when the too-young-to-remember-Munich become a major part of the voting public? There's a grim-funny quote from somewhere:

"History doesn't *always* repeat itself. Sometimes it just yells, 'Can't you remember anything I told you?' and lets fly with a club."

CLEO HINDMAN

Box 32
Stockport, Ohio

Love that quote!

Dear Mr. Campbell:

Concerning the "Explanations" offered on page 70 of the February 1967 Analog, I should like to call your attention to the following two observable tendencies of today:

1) People all over the world attach more and more importance to articles produced practically this very instant. Everything has to be new, fresh, crisp, latest edition, straight off the assembly line, look mint-condition, smell of ink, taste of dew, feel like new, and what have you.

2) There is a definite trend in English-speaking countries toward the adoption of the Metric System; judging by recent books of well-known science writers, where figures are almost invariably given in kgs and kms—pounds and miles being added in brackets.

In view of this I'm quite sure you'll agree with me that the expression "O.K." shall be originated in the near future as the simple and logical abbreviation of the concept "zero kilometers"—meaning unused and, therefore, perfect—and that it has been introduced into the nineteenth century by British or American time-travelers of the year 2,000.

IAN GROOM

Parana 259, Villa Ballester
Buenos Aires, Argentina

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And O.K. means "on target" maybe?

Dear John:

The excellent article "Target: Language" in the May issue prompts a couple of comments. Although implied, it is not stated that a language not only becomes simpler as it develops, but also more irregular. Thus English, although simpler in form than older Indo-European languages, is not necessarily easier to learn, due to its irregularities, especially in spelling.

Mr. Perkins also left out one tense; the future emphatic of "I shall see" is "I *will* see." Strangely enough, in the second and third person the auxiliaries are reversed so that "You will see" is simple and "You *shall* see" is emphatic. At least, that is the way it was taught to me in school. In reality, most practical people ignore such distinctions these days, and "shall" is dying out, at least here in the U.S., aided by the frequent use of contractions like "I'll."

I agree that the infantile proto-language should be studied, especially since it would appear that some basic words such as "mama" are spoken by all babies. This might be the proper approach by which to construct a successful universal human language.

BERESFORD SMITH
306 Ninianne Boulevard
Princeton, N. J. 08540

Spanish is also a highly evolved language—but it's very easy to learn, and has a nearly faultless orthography.

Dear Mr. Campbell:

I enjoyed your editorial "Peace in Our Time" and heartily agree with you, except in one instance. You state "Hm-m-m . . . and we're also not intransigently insisting on One And Only One Right Way."

In light of this statement how do you explain the fact that almost every country that our soldiers have gone into, either peacefully or otherwise, has been almost forced, willy-nilly, to accept majority vote rule. It happened in Germany—I know that they had a form of Democracy before Hitler; Japan, and now Viet Nam. Your statement "Sometimes dictatorship is the best form of government . . ." seems to apply better in the case of Viet Nam than the argument in favor of democracy.

The Viet Cong obviously want to force their form of government on South Viet Nam. That is why we are fighting them. But, on the other hand, aren't we attempting to force Viet Nam to accept Democracy—our One And Only Right Way?

W. WILLIAM SMITH
937 Fickle Hill Road
Arcata, California 95521

The problem our leaders face is very difficult. The American people do believe Democracy is the only right way. They don't appreciate that a representative limited

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Monarchy can be a better form of government than a bad, imposed, Democracy. This gives wise leaders quite a headache!

Dear Mr. Campbell:

I'd like to point out a common flaw in the layman's concept of probability which was demonstrated in your March issue by Messrs. Smart and Embs. Suppose we have a pack of playing cards, the probability of choosing say the ace of spades is 1/52. If we choose a card and lay it face down, the unenlightened would say that the probability of it being the ace of spades is 1/52. This is just not true. The probability of this card being the ace of spades is either certainty or zero. Probability exists in the *choice, not* in the result since the end product either exists or it doesn't exist; e.g. Mr. Smart would be quite wrong in saying that only one part in 10^{23} of John Campbell exists.

Having got that off my mind, I'd like to venture a prediction about the forthcoming attempt to verify Einstein's Theory of Relativity by launching an atomic clock into orbit. It is expected that the clock in space will slow down, with respect to one on Earth, because of its orbital velocity. But, according to the general theory of Relativity, a clock on Earth beats slower than one in space due to the effect of gravity. Any high school kid, examining the way bodies behave in a gravitational field, can show that the slowing down of the clock due to the orbital motion is just equal to the amount it speeds up due to the decrease in the gravitational flux; i.e. the times shown on the two clocks after any interval of time will be the same.

M. B. MALONE

43 Manor Place
Edinburgh, Scotland

The space clock will probably stop, failing the experimenters, due to space sand in the works.

Dear Mr. Campbell:

QUALMS

The world is already too crowded with things,
But each day more news of discovery brings
As our troops of deep thinkers keep making their marks—
"Quasars" were bad enough, and now we have "quarks!"

Scientists seem to have made this an age for
Items that Webster just hasn't a page for,
So they think up new names to apply to their larks,
And that's how we get things like quasars and quarks.

Getting used to these fanciful flights isn't easy—
To think of a quasar makes me slightly queasy.
And now someone's super-acute brain uncorks
Some gizmos that may be pronounced—who knows?—quorks!

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My poor cerebellum is getting each day scars
From trying to grasp concepts like quarks and quasars;
I'd sooner accept baby-carrying storks
Than think that there really are quasars and quarks!

CLAUDIA JENSEN
1221 Kemp,
Missoula, Montana 59801

And maybe they suddenly, silently vanish away because some quarks are quojums?

Dear Editor:

Your indictment of the historical idiots, "Peace In Our Time . . ." (April, 1967), was excellent but your assessment of communism in Russia was illogical.

You say (1) "the Russian people have every reason . . . to feel communism is a great thing"; (2) "Communism was of immense benefit to Russia"; and (3) "Communism can be a highly workable socioeconomic system."

As for (1), they didn't want it to begin with. Bad as things were under the Czars, they didn't want communism to "save" them. The election of November 25, 1917 showed the Bolsheviks getting only nine million out of a total vote of thirty-six million. The elected Parliament, dispersed by the communists, would have had 420 non-communist members to 225 Bolsheviks. They lacked popular support so badly that a great civil war occurred from 1918 to 1921 killing 14 million. Riots occurred among factory workers. Intellectuals were so anti-communist, many had to be murdered.

Forty-one years later, the Russians still didn't think communism was a "great thing." A study by the Library of Congress published in 1958 declared 10,300,000 people disappeared—you know what that means—from the Ukraine; Byelorussia lost 4,500,000 in deportations and executions; in the Caucasus, 422,000 were sent to Siberia or killed.

As for (2) and (3), you've got to be kidding. Just to show that communism is not a workable system and is not of any benefit to Russia, let us look at food production. Soviet propaganda has spread the idea that Russia before the revolution was a country of hunger. Untrue. Except in the years of extremely serious drought, there were surpluses for export.

Here are the facts: In Russia, private enterprise has beaten communism whenever tried. A U. S. Department of Agriculture report says that, although private plots constitute only 1.4 per cent of Russia's total agricultural area and 3.3 per cent of the total sown area, in 1962 they accounted for about one third of gross agricultural output, including almost half of the total output of livestock products. Professor Ellsworth Raymond of NYU has said that without these small gardens, communist Russia would starve.

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In the United States, ten per cent of the work force lives on the land, one farmer feeding himself and twenty-nine others on a high protein diet. In communist Russia, one farmer feeds himself and only six others on a seventy-five per cent starchy diet. Communist productivity is on the level of the U.S. in 1870.

You stand corrected.

DANIEL JOHN SOBIESKI
5525 S. Monitor Avenue
Chicago, Illinois 60638

Tsk! tsk! Don't be so narrow-minded —and don't interpret so narrowly. Sure, the Russians of 1918-19 didn't want the Bolsheviks. What I said was that the present Russian people have every reason to hold it's a good system.

That Library of Congress study I don't know anything about—but it sounds as though somebody has taken data out of context, or forced it into the wrong context. Siberia isn't a prison any more, you know; it's a rapidly developing area of immense resources.

Yeah—look at food production in Russia! What's the population increase since 1919? What proportion were farmers then?

And your real narrow-mindedness is in making a one-to-one correlation between the U.S.S.R. and "communism." Try again, friend! Most early Christian communities were communes. Most monastic orders are today. As I said, under some conditions, communism can be the optimum socioeconomic system. The Leninist error is the intransigent insistence that it always is.

Dear Mr. Campbell:

May we urge all supporters of intelligent science fiction on television to write immediately to NBC or Gene Roddenberry at Desilu-Gower Studios in Hollywood, calling for the continuation of the NBC-TV series "Star Trek," which is in danger of being canceled next year.

To those of us who have been reading magazines such as Analog (Astounding) *et al* for more years than we care to remember, "Star Trek" answers a long-felt desire to see something of science fiction on television not on the one hand superficial, silly and dull, or on the other hand spotty and of undependable quality. It would be a shame indeed to cut off this show and continue other offerings on television of, to put it mildly, highly questionable value.

We hope that many of you will respond and perhaps have some effect on what appears on the idiot box.

Yours very truly,
THE REV. C. CALLAWAY III
MARGARET E. CALLAWAY

203 Hickory Avenue
Bergenfield, New Jersey 07621

"Star Trek" is the only real science fiction for adults TV has ever presented. The nearest next show is "Time Tunnel," about one third as good!

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THE RED AND BLUE GIANT

continued from page 7

lium-fusion runs into the difficulty that the reverse reaction, Be^8 breaking down to He^4 yields 18 million electron volts of energy. And it has a half-life of something like 10^{-20th} seconds. Under any vaguely reasonable conditions, that improbable two-heliums-to-beryllium reaction isn't going to happen. It absorbs energy, and even if the Be^8 is formed, it breaks down so quickly it's effectively not there at all.

However, $3\ He^4 \rightarrow C^{12}$ is the next step in helium fusion—and C^{12} is the normal, stable carbon isotope. *That* reaction *does* yield energy. Moreover, from there on, the star's in business, because $C^{12} + He^4 \rightarrow O^{16}$ and $O^{16} + He^4 \rightarrow Ne^{20}$ and $Ne^{20} + He^4 \rightarrow Mg^{24}$ and . . .

If the star can once get past that excessively unstable Be^8 isotope, it's in business again, and has a fuel supply good for quite a while.

As the density of the plasma at the star's core increases, the pressure rises, and the temperature rises —and the time between one collision between nuclei and another decreases. Greater density means decreased distance between nuclei, and decreased means free path between collisions. Higher temperature means higher individual velocity, which means decreased time to cover the decreased distance between nuclei.

At a temperature in the range of 10^8 °K, with a density of fantastic magnitude, the time between nuclear collisions gets down around 10^{-22} or less seconds. Under those conditions, 10^{-20th} seconds is a long time; that hyperunstable Be^8 now rates as a long-established citizen—it's been through hundreds of collisions before even its explosively short lifetime ends. And surrounded by He nuclei as it is, what now happens is $He^3 + He^4 \rightarrow Be^8 + He^4 \rightarrow C^{12}$ . . . and the whole chain of helium additions can take place. Short as the half-life of Be^8 is, when temperature and density get high enough, it becomes long relative to the time-between-collisions—and the helium fusion chain unlocks.

However, the events in the giant star are a little more complicated. When the star's core exhausts its hydrogen, the radiation output begins to fall—and that means that gravity goes to work. The stupendous mass of the star's bulk presses inward—the temperature goes up, despite the loss of nuclear energy, and the last dregs of hydrogen are squeezed and roasted into fusing. The core gets hotter and hotter—and the zone immediately above the core gets hotter, too.

Heretofore, the zone just outside the core has *not* been reacting, because it was below the nuclear fusion temperature. There's very little

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mixing of layers on stars; studies show that under the pressure, density and temperature gradients inside stars, each zone tends to stay at its own level for billions of years, with very little mixing. So the zone immediately outside the core zone still contains practically all the original hydrogen concentration it started with—and when the core starts superheating, it finally gets hot enough to start fusing.

From here on, the star's thermonuclear energy is supplied almost entirely by a zone of fusion outside the core—a shell of fusion. This is now maintaining the star's temperature and energy release; the core, entirely surrounded by the burning zone, doesn't cool off, but doesn't heat up much, either—remember it's already well above the temperature of hydrogen fusion.

Slowly, however, the inner zones are exhausted, and the burning shell moves outward—while the central zones *do* begin to warm up some more, and the density of the star's interior increases. It will, eventually, force the core over the Be^8 hump, and start helium fusing—but that's a later stage. The fusion-shell stage is the stage of the Red Giant star.

When that fusion-shell stage gets going, the star is forced into some massive readjustments. The inward collapse of the central parts, as the original core stopped fusion, caused that interior to rise in temperature —and rise by several millions of degrees. The new fusion shell is markedly closer to the radiating surface than was the fusion core.

The surface of the star gets pushed far, far out into space—immensely deep layers of tenuous gases expand out millions and tens of millions of miles. Instead of having a corona layer a million or so miles deep as our Sun has, that layer gets pushed out and becomes perhaps 100,000,000 miles deep. The atmosphere of the star balloons out to a hypertenuous, hot envelope so extensive it would quite normally reach out to the orbit of Mars—some red giants appear to be large enough to reach out as far as Jupiter, 500,000,000 miles.

BUT . . . these vast envelopes aren't going to contain much of the star's mass; they'll be the most tenuous sort of gas-dust cloud, because the process going on in the star is one that requires *higher,* not lower, density. That fusion shell is slowly burning its way out—and the star is forced into a sort of compulsory profligacy. The surface has been expanded; there will be gravitational collapse if it doesn't produce enough radiation-pressure. So it is forced to release energy even faster.

The "surface" now becomes an interesting question.

Look: If you take an ordinary electric room-heater heating element—one of the sunbowl type—and surround it with insulation—vermiculite, or asbestos, or mica chips—two inches deep, you can

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make a fine little electric furnace. You'll need a variable transformer to step down the power, because with that deep insulation around it, instead of being free to radiate into space, the nichrome heating wire will rapidly heat far above the normal 1,100° C it's designed for if you supply it with its rated 1,000 watts. The ceramic cone itself would melt if the nichrome wire didn't melt away first. But it makes a very cheap, very useful small electric furnace, in which small commercial crucibles fit neatly, when an additional asbestos insulation lid is put on top. It will melt copper, silver, brass, and, of course, the low-melting materials like aluminum, lead, tin, et cetera.

All you have to do to make something get hotter, if it has an energy supply inside, is to wrap it up in insulation.

Now the outer 100,000,000 miles of a red giant star is mighty tenuous —but it would insulate the star's main mass from direct exposure to space!

My suspicion is that the "original surface" of the giant star has shrunk somewhat, due to the inward collapse, plus the huge—absolute—quantity of mass, though that mass is—relatively—minor, lost to form the ballooned atmosphere. And that that "original surface," now insulated from direct radiation into space, and heated by the fusion zone moving out from the core, would be most virulently, violently hot. It would be dazzling at 100,000° + temperatures. A core of appallingly hot "original surface" deep in those vast, tenuous gas-dust clouds.

From our immense distance, the star, as a whole, appears to be a red-excess star—because we're not able to resolve the actual appearance from our distance. But, close up, we'd see the ferociously radiant central star deep in a red-glowing mass of gas-dust atmosphere. The central mass would be dulled, dimmed, and reddened to some considerable extent—but the overall appearance of a red-giant star, seen at close range, would, I suspect, be as Chesley Bonestell has painted it—a vast, glowing atmosphere of gas dust, tenuous as the inside of an ordinary radio tube, hundreds of millions of miles deep, with an inner core of the true star, dulled, dimmed, and smothered, but still a fierce blue-white true surface.

There's an additional effect that I can't evaluate. Astrophysicists say that a class cBO star—a super-giant blue-white of the Rigel—an S Doradus blue-white "brightest-star" type —or a Wolf-Rayet star of Class O —radiates so furious a flood of ultraviolet energy that it can ionize every atom of hydrogen in space *for 75-100 light-years* around.

The Ring Nebula in Lyra appears to be a brilliant blue-white sun surrounded by a perfect smoke ring of glowing gas. Appearance is deceptive; it is, in fact, surrounded by a sphere of gas which is fluorescing

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under the excitation of the blue-white giant's UV radiation. It is a *relatively* dense gas cloud, far denser than interstellar space generally, but still better than the vacuum in a vacuum tube. The UV output of the star can't ionize every atom of hydrogen for one hundred light-years around when it's forced to shine through so dense—relatively—a gas cloud—but it can ionize the gas cloud pretty thoroughly.

However, the glow of the excited gas is extremely feeble; only when we look along a path trillions of miles long does the feeble glow add up to enough to be visible to us.

Since we're looking along a chord of the sphere of gas, the farther out from the star, the greater the diameter of the sphere, the longer the chord of line-of-sight, and the more glow we see.

With, however, a limitation; eventually the density of the gas cloud falls to that of normal interstellar space. At that point the chord of the line-of-sight may be many light-years long, but the density of the fluorescing gas has fallen so low that no glow is visible.

Result: the appearance of a glowing ring of gas around a brilliant blue-white star.

Would a comparable ring-effect show up in a giant red puff-ball star at a close-in distance—a planetary distance where structural details could be seen? Perhaps the appearance would be that of a blue-white central mass about 10,000,000 miles in diameter—remember we started with a star many times more massive than our Sun—surrounded by an even more brilliant fluorescent ring perhaps 50,000,000 miles in diameter, all set in a vast glowing sphere of red-glowing tenuous gas dust. Much of that red-glowing stuff could be plain, ordinary red-hot soot —carbon dust—as the hugely expanded atmosphere cooled below the sublimation point of carbon. There would be billions of tons of solid material in that gas-dust cloud —at 3,000° absolute, tungsten's a solid, rhenium, thorium oxide, and more esoteric materials like hafnium nitride and carbide, are more than 1,000° below their *melting* point!

Yet, at interstellar distances, this complicated, multi-layer structure would blend into the appearance of a single reddish-white "red giant star." A standard ten to fifteen power hand lens will show you that the smoothly colored areas of a color print in any magazine are, in fact, made up of a very complex structure of red, yellow, blue and black dots, the half-tone screen dots of the photomechanical reproduction technique. They blend to the eye into one color, because the eye can't resolve the fine structure.

No possible telescope can resolve the fine structure—if any—of Betelgeuse from Earth. And the telescope will simply give an average spectrum for the whole star's radiating system. The Editor.

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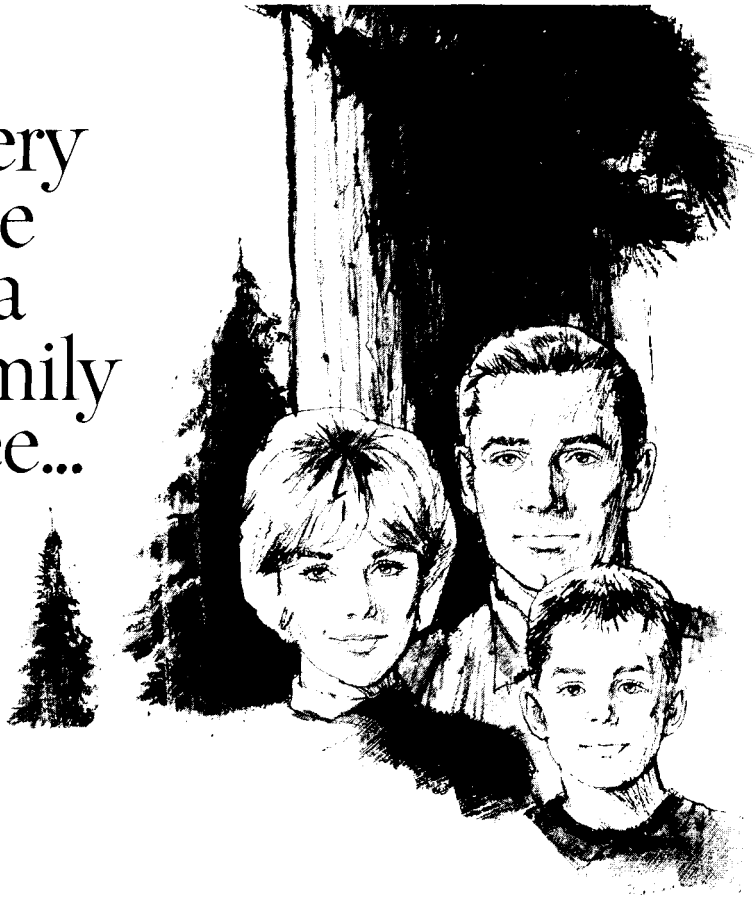

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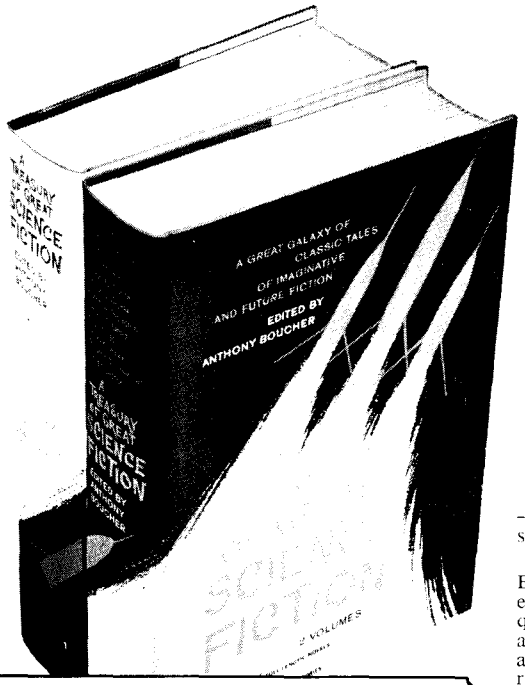

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